PRACTICAL
ENGINEER
Trade-mark, Reg. U. S. Pat. Off.
SEMI-MONTHLY
VOL. XX. CHICAGO, NOVEMBER 1, 1916 No. 21

Aurora, Elgin & Chicago R. R. Power Station

STANDARDIZATION OF BOILER OPERATING CONDITIONS
RESULTS IN A PERMANENT INCREASE IN EFFICIENCY

FIFTEEN YEARS AGO, when plans were formulated for the construction of a third-rail interurban railroad connecting Chicago with the 2 active cities of Aurora and Elgin, it was logical that the site of the generating station should be on the Fox River, from which ample water might be drawn for condenser use. Batavia, 6 mi. north of Aurora, was selected as a favorable location, and a 4500-hp. plant constructed.

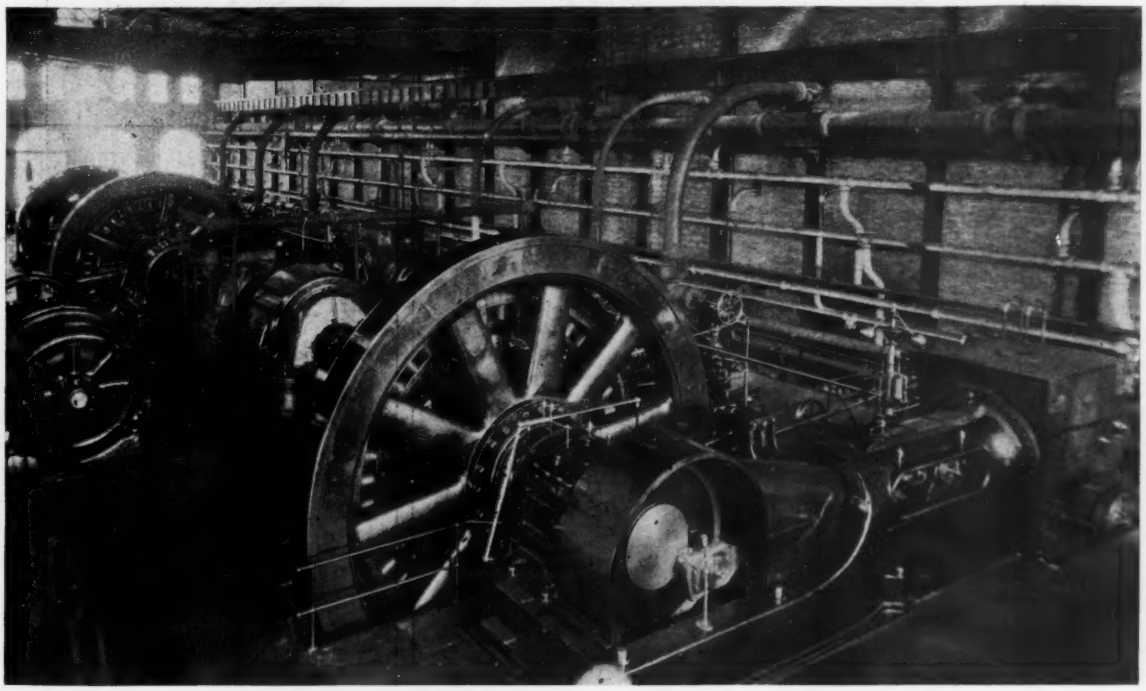


FIG. 1. INTERIOR VIEW OF A. E. & C. R. R. POWER HOUSE

In keeping pace with increased load demands and to effect greater economy of operation, the original installation of 3 1500-hp. Corliss engines was supplemented by the subsequent addition of another 1500-hp. Corliss engine, a 2500-kw. low-pressure turbine and a 7500-kw. high-pressure turbine, giving a present capacity of over 19,000 hp.

Elgin and Aurora lines converge at Wheaton, as indicated in Fig. 6, and the cars are coupled together, running into Chicago as one train. A triangle is completed by the section running between Elgin and Aurora, and branches extend to Carpentersville on the north and Yorkville on the south. The total mileage is about 170. Dairying is an important industry in this section of the Fox River Valley, and a speedy freight service, of which dairy products form the bulk, is a profitable source of revenue.

In addition to its own load, power is supplied to the Aurora & De Kalb Interurban R. R., the Aurora, Plainfield & Joliet Interurban R. R., and the Elgin, Belvi-

dere & Rockford Interurban R. R. Light and power is also furnished to Elgin, West Chicago, Wheaton, Glen Ellyn, Elmhurst and intervening towns.

About 3,700,000 kw.-hr. is a typical monthly output of this station in summer. Any tendency for the load to increase during the winter months, due to heating the cars and extended lighting periods, is counterbalanced in a limited measure by the absence of excursion trains and heavy traffic. Approximately 3,000,000 kw.-hr. constitute the operating demands for the road, and of the 700,000 kw.-hr. sold, 600,000 kw.-hr. are disposed of as 25-cycle alternating current and 100,000 kw.-hr. with frequency changed to 60 cycles are delivered as lighting current.

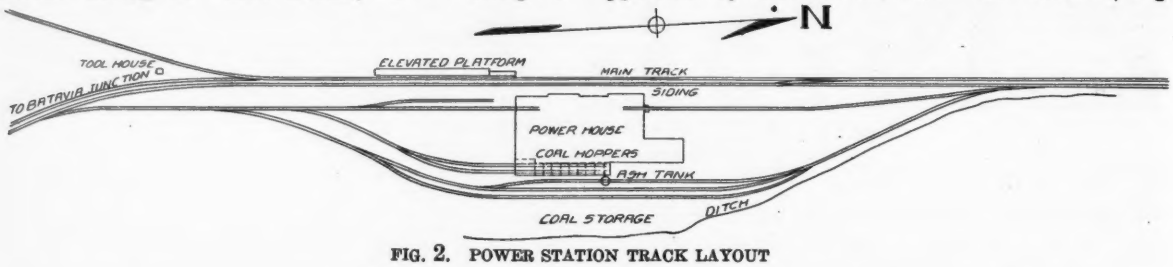


FIG. 2. POWER STATION TRACK LAYOUT

On the run to Chicago, in which a large number of down grades are encountered, it has been experimentally determined that power can be shut off at the controller as high as 75 per cent of the time without materially reducing the train speed. Further experiments are now being conducted by the electrical engineer, E. S. Gillette, to determine the extent to which this coasting effect may be advantageously applied in reducing the operating current demands.

Railway power service possesses peculiar characteristics. On this system, trains arrive and depart at approximately half-hour intervals. This condition, augmented by the departure within a few minutes' time of connecting interurban trains, which are tied on the same line, imposes upon the generating station a heavy starting current demand, which causes the load curve to hump up into half-hourly peaks.

Boiler House Operation and Equipment

Subsequent to the appointment of a boiler-room foreman, 3 yr. ago, the boiler-room efficiency has been increased 40 per cent. This is but one of a rapidly increasing number of instances in which intelligent concentration on boiler-room administration has been recognized as a vital factor in the general station efficiency.

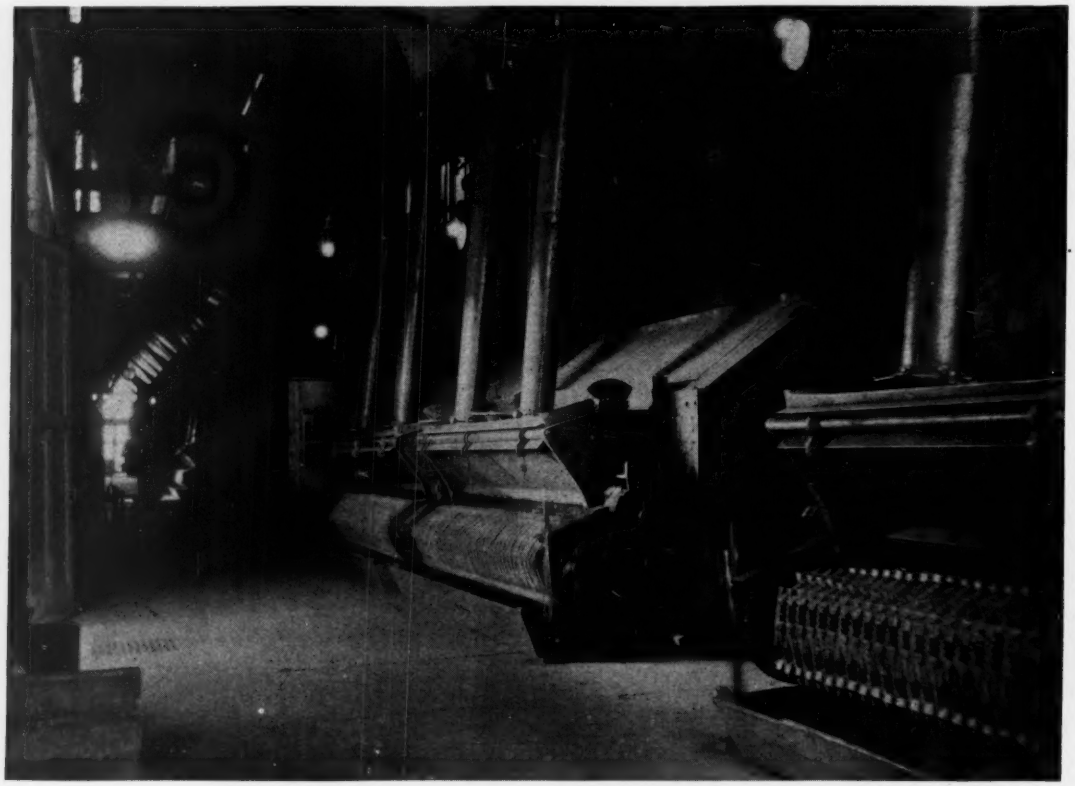


FIG. 3. FIRING AISLE OF BOILER ROOM

Conditions detrimental to efficient boiler operation commonly lie concealed and therefore disregarded. In-

creasing the boiler room efficiency as much as 40 per cent does not ordinarily require complex or radical alterations—simply an intelligent analysis of existing conditions, followed by the application of some very ordinary remedies. That was the procedure at this plant.

Before any tests were attempted, each boiler received a thorough scouring and scale was removed completely—for the first time in some tubes. Combustion chambers and breechings were the next to receive attention, and many a barrow of soot and dust was removed. An inspection showed that the front baffles of several boilers had shifted and these were correctly reset.

Operating tests disclosed the fact that in some of the boilers combustion was imperfect. It was experimentally determined that by adding one or 2 rows of tile to the first baffle and thus reducing the flue gas velocity, combustion was materially improved. On some of the boilers, the width of the first pass exit was diminished by 3 ft.

5 in., 12 per cent of CO_2 at the damper, and boiler operation at 200 per cent rating were standards adopted as a definite basis of operation. In some instances, however, a deviation from the standard is to be expected, owing to the character of the fuel, nature of the load, etc.

Perhaps the most commendable feature of the increased efficiency of this boiler house, is its permanence. It has not been permitted to become ragged or spasmodic, or burst as a soap bubble; it has been maintained religiously. All boilers are subjected regularly to an evaporation test to determine their condition, and a record of this test is placed on file in the boiler-room foreman's office. Information contained on the boiler-room log sheet is closely observed by the boiler-room foreman, and any decided variation in the daily values for kilowatt per boiler horsepower or the pounds of coal per kilowatt is investigated.

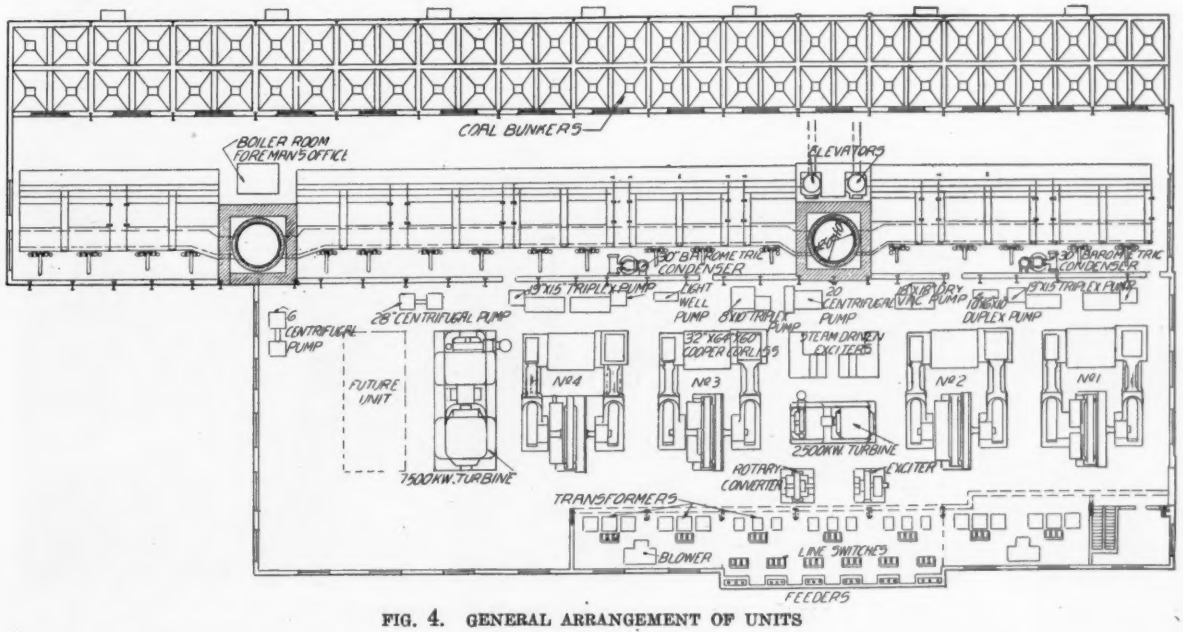


FIG. 4. GENERAL ARRANGEMENT OF UNITS

Draft and CO_2 values and thickness of fire were then investigated and after extensive tests were made, standard values were adopted. Previously, no draft gages or instruments for flue gas analysis were provided, and the firemen did not know whether CO_2 was a slang expression or a new form of boiler compound. Differential draft gages were installed on each boiler, an Orsat instrument and a continuous CO_2 recorder were provided, which could be connected to any boiler, and portable steam flow meters were placed on several of the boilers. The importance of maintaining the proper conditions essential to good firing was then explained to the men, and as a result, they took a broader interest in their work and their abilities were enlarged.

Extensive evaporation and fuel consumption tests applied to all of the boilers, made it apparent that the best results were obtained when the draft over the fire was approximately ⅓ that at the damper, or about 0.32 in. and 0.95 in. respectively. A fuel bed thickness of

On one-half of the boiler room log sheet is recorded the customary data such as: Line diagrams of boilers in full service and boilers banked, total number of boiler horsepower-hours, boilers down for inspection and repair, details of repair and approximate time required, number of men working on coal and ashes, number of repair men, kinds of coal being used, tons of coal, total B.t.u., and weightometer readings.

Placed in one section of the remainder of the sheet are the hourly readings of stack draft, outside and inside temperatures, and minimum steam pressure. In another section are recorded such constants as: Total hr. run of ash system, total hr. run of coal conveyor, average tons coal handled per hr. by conveyor, total lb. water, total lb. coal, total B.t.u., total kw.-hr. output for the day, maximum ½-hr. peak in kw., kw. per boiler hp. rating at peak, lb. water per lb. coal, lb. water per kw.-hr. output, lb. coal per kw.-hr. output, B.t.u. per kw.-hr. output, and average load factor based on ½-hr. peak.

Below these 2 sections ample space is provided for remarks; noted here are all unusual occurrences, anything affecting the service, suggested improvements, and information on tests in progress.

Coal arriving at the station is taken in self-dumping cars to one of the 2 tracks placed at the east side of the boiler house. For immediate use, it is dumped into a 200-ton hopper from which it drops to a 4-roll Orton-Steinbrenner crusher which is driven by a 25-hp. induction motor. On leaving the crusher, the weight is automatically recorded by a Merrick weightometer, whence it is elevated and distributed to the overhead bunkers by a 22-in. Robins conveyor belt system, which is under the control of one man.

Beyond the main receiving hopper are 9 smaller hoppers filled with a reserve coal supply, which in an emergency may be dropped to a reclaiming conveyor belt and carried to the crusher. These hoppers are indicated in track layout shown in Fig. 2, and have a combined capacity of 1800 tons. An outdoor storage yard has a capacity of 15,000 tons.

After 9 yr. of operation, increased steam demands necessitated an extension of the boiler house and 8500-hp. Edge Moor boilers were added to the original installation of 10 500-hp. boilers of the same make.

Boilers are of the 3-pass water-tube type, and generate steam at 180 lb. pressure. Green chain grates are installed, which operate from eccentric rods on a motor-driven stoker shaft located beneath the boiler-room floor; while 2 stacks, each 235 ft. in height above the grates, and with an 11-ft. diameter at the top, furnish an abundant natural draft. Mechanical soot blowers are provided on each boiler, and 10 of the boilers are equipped with Geco high-pressure water backs.

Feed water is heated in 2 Cochrane metering heaters, the rate of flow to the boilers being controlled by Williams feed water regulators.

During fuel consumption tests, a portable Richardson automatic weight recording scale is placed in front of the stoker hopper, and a meter in the feed-water branch to each boiler measures the water. With banked boiler hours commonly ranging from 30 to 35 per cent of the total boiler hours, a yearly coal consumption average gave 3.17 lb. per kw.-hr. at the switchboard.

Placed at the middle of the firing aisle is a large illuminated pressure gage which reads from 165 lb. to 195 lb. Small variations from the standard 180-lb. pressure result in comparatively large movements on the dial, thus making the change quickly apparent and enabling the fireman to check immediately any further variation.

Situated near the firing aisle is the inclosed office of the boiler-room foreman, as shown in Fig. 4. Here are found the continuous CO_2 recorder, and in addition to the usual draft and pressure instruments is a 6-pen graphic recorder which has some commendable features. This instrument indicates when and how long the coal or ash system motors were in operation; when and how long pop valves and blowoff valves were open; when the damper regulator was shut tight, and when the heater overflowed. In each instance, the closing of a simple contact placed on the starting switch of the motors or in a reliable manner on the other apparatus, closes a circuit containing a small series induction coil, and the slight deflection of the recording pen which results is maintained until the contact is broken.

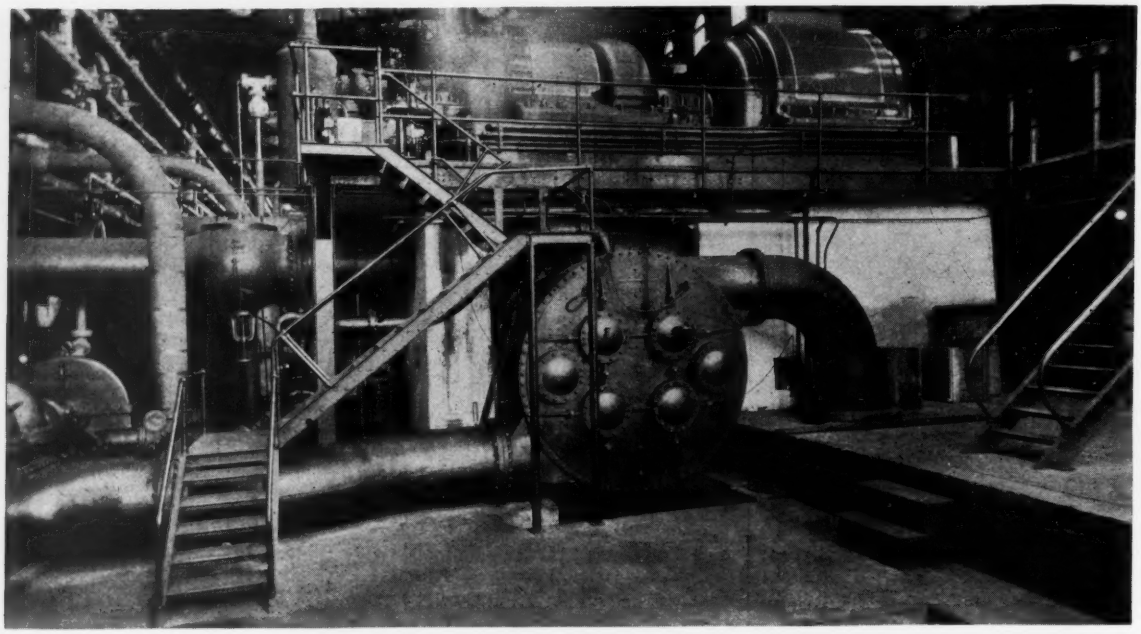


FIG. 5. HIGH-PRESSURE TURBINE AND CONDENSER

Ashes are conveyed by a pneumatic system to an outside 45-ton tank from which they are dropped into cars. Should a breakdown occur in this system, ashes may be drawn into small cars which are pushed along a track in the under room to an elevator, which raises them to a level above the boiler room coal hoppers, and are then dumped into 2 emergency ash hoppers, with a capacity of 30 tons. Fine coal is returned to the coal hoppers by this same method.

Engines and Turbines

During their 14 yr. service, the C. & G. Cooper cross-compound Corliss engines have established an enviable record for reliability. Three of these engines are 32 by 64 by 60 in., operating at 75 r.p.m.; the fourth engine is 32 by 64 by 48 in., with a speed of 94 r.p.m. Vacuum is supplied by 2 30-in. Worthington barometric condensers.

Direct-connected to each of the engines is a 1500-kw. General Electric 25-cycle alternating-current generator delivering 2300 volts at 377 amp.

Between the central Corliss engines, as shown in the plan view of Fig. 4, are the low-pressure turbine, 2 engine-driven exciters, a motor-driven exciter, and a rotary converter.

Exhaust steam at 3 lb. gage pressure operates this Curtis low-pressure turbine after it has been started with high-pressure steam flowing through a separate set of nozzles. When the turbine and its surface condenser are in complete operation, the barometric condenser of the engine is cut off by hydraulic valves in the exhaust header.

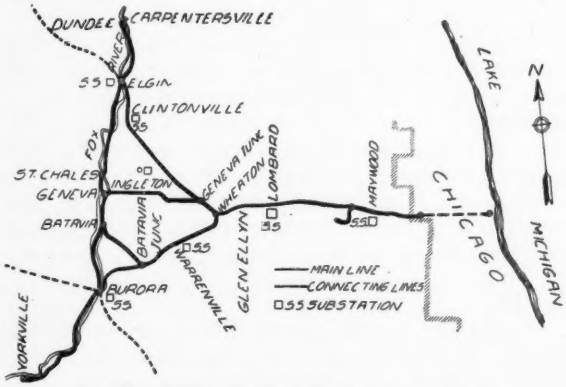


FIG. 6. RIGHT-OF-WAY OF A. E. & C. R. R.

Ordinarily the exhaust steam is furnished by one of the engines next the low-pressure turbine which operate either condensing or noncondensing; the exhaust valves of these engines being set to close about 3½ in. before the end of the stroke. On the other 2 engines, which exhaust to the barometric condensers, the exhaust valves close about 7½ in. before the end of the stroke.

Driven by this low-pressure turbine at 1500 r.p.m., is a 2500-kw., 3-phase, 25-cycle General Electric generator delivering 630 amp. at 2300 volts.

Ample room was provided for a future unit when the engine room was extended 5 yr. ago to permit the installation of the high-pressure turbine, which is of the Curtis type and drives a 7500-kw., 3-phase, 25-cycle General Electric generator at a speed of 1500 r.p.m. A bypass valve allows live steam to enter the 5th pass if it is desired to run the unit at overload capacities. Vacuum for this unit is supplied by an Alberger Spiroflo condenser, shown in Fig. 5.

Two 160-kw. exciting-current generators are driven by direct-connected 14½ by 15-in. engines, at 230 r.p.m., and a 300-kw. exciter by a 450-hp. induction motor running at 375 r.p.m.

Direct current for the railway motors on the Batavia section is provided by a 500-kw. rotary converter.

Pumps

Situated along the east side of the engine room are the circulating, feed water and service pumps. Water for the 2 barometric condensers is delivered by 4 19 by 15-in. Dean triplex pumps operated by 35-hp. induction motors.

To satisfy the requirements of the surface condenser of the low-pressure turbine there is a 20-in. motor driven Worthington centrifugal pump of the volute type, with a capacity of 10,000 gal. per min. Also serving this condenser is an 18 by 18-in. Worthington dry vacuum pump driven by a 25-hp. induction motor. Circulating water for the condenser of the high-pressure turbine is delivered by an Alberger 3-stage, 28-in. volute pump driven by an Alberger-Curtis turbine.

Boiler feed water is commonly supplied with a Westinghouse turbine-driven 6-in. centrifugal pump operating at 2200 r.p.m. House service water is provided by a Worthington steam-driven 17 by 10 by 15-in. duplex

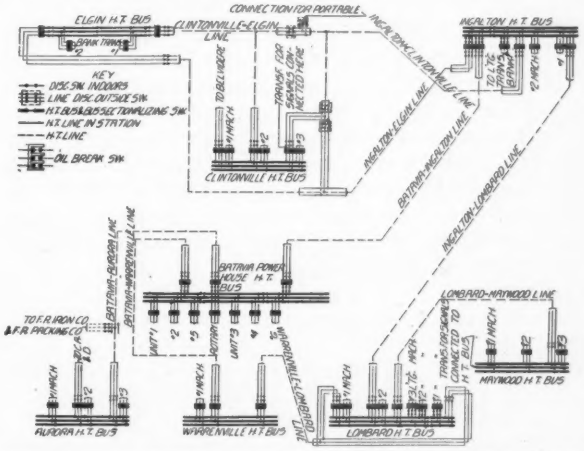


FIG. 7. HIGH-TENSION LINE CONNECTIONS TO SUBSTATIONS

plunger pump and a Worthington motor-driven 8 by 10-in. triplex pump. If necessary, these 2 pumps may be used for feed-water service.

Simplicity is noticed in the arrangement of the main pipe lines. They are supported on the east wall of the engine room, as shown in Fig. 1. At the top is the tan-colored live steam header, then the 2 white feedwater lines; service pipes are blue, exhaust headers are green, and the circulating water lines are black.

Substations

Current is generated at 2300 volt, 3 phase, 25 cycle, delta. From the generator the current passes through delta-delta transformers and is stepped from 2300 volts to 26,400 volts. Next the 3 phases run through current transformers and then into an oil switch. From the oil switch each phase goes through choke coils to the generator disconnecting switches, and from the generator disconnects to the main station bus. Each generator in the power house feeds directly onto this bus in a similar manner. From the main station bus there are 3 line taps for lines running to Aurora substation, Ingalton substation and Warrenville substation.

After it leaves the main station bus the path of the current is through the first set of line disconnecting

switches, then into the line oil switch, from there through current transformers, then through choke coils, and through the second set of disconnecting switches into 2 cross-country lines.

As shown in Fig. 7, the line to the Warrenville substation, and that to the Ingalton substation continues through to the Lombard substation where they are joined together, forming a loop. From the Ingalton substation there is one line running directly to Elgin substation and another line running to the Elgin substation by way of the Clintonville station, forming another loop.

This arrangement makes 2 paths for the current to each of the 5 substations. The remaining stations, Aurora and Maywood, are fed by a single line from the power house and Lombard substation, respectively. However, due to the length of these lines, up to the present time it has not been found necessary to make a duplicate line.

Arriving at one of the rotary substations, the current is transformed and converted to 600 volts d.c. and applied from power house to the rail is about 79 per cent.

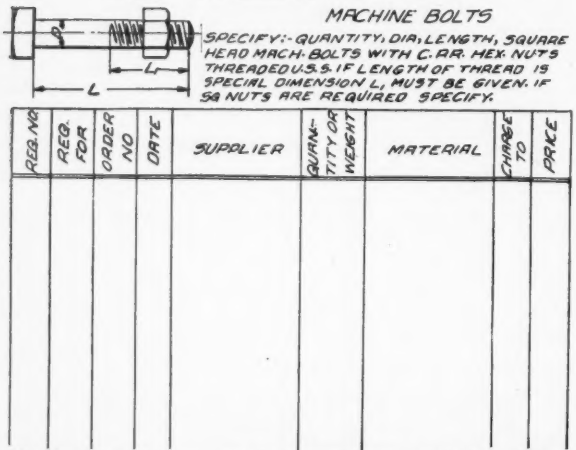
To meet emergencies, the road maintains as a portable substation, a car equipped with transformers, switchboard and rotary converter. Should a breakdown occur at any regular substation, this portable installation is capable of carrying the load until the necessary repairs are made.

The Two Great Principles of Successful Buying

PROPER SPECIFICATIONS AND DEFINITIONS; SECURING GENUINE COMPETITION. BY H. B. TWYFORD

PURCHASING holds an important strategic position in any commercial undertaking, in that it precedes every other activity. Construction work cannot proceed until the necessary tools, equipment and materials are procured. A generating station cannot start up until supplies are accumulated to insure its smooth operation and coal has been bought and stored in the bunkers. Developments, therefore, in the art of buying affect every undertaking in the realm of construction, transportation, manufacturing and commerce.

FIG. 1. PURCHASING ORDER RECORD.



Showing method of putting in force Standard Definitions. Whenever possible, it is advisable to have a small sketch, as shown on the above specimen of a machine bolt. This question of maintaining and enforcing Standard definitions applies to every article purchased and when in good working order the benefit will be appreciated throughout the organization.

When a purchasing agent buys any manufactured article he is purchasing in a composite form all the materials which go to make up that article. The manufacturer of electrical apparatus, or of typewriters, or loose leaf ledgers had to buy various materials to produce these articles and these materials were the finished product of some antecedent manufacturing process.

This tracing back process can be continued until the original raw material is reached. The function of buying is exercised many times during this progress and if in these movements the execution of it can be more economically administered it has a very appreciable effect on the ultimate cost of the finished product.

Recently there has been increased interest shown in purchasing and a better understanding of its importance is being realized. This is apparent not only among executives, but also among the buyers themselves. Many new associations of purchasing agents have been and are being formed in all sections of the country and regular meetings are being held for the interchange of ideas having in view the improvement and betterment of purchasing methods.

THE TWO FUNDAMENTALS

THERE ARE 2 great basic principles involved in buying anything, and if these are kept constantly in view and lived up to, the foundation for successful buying is assuredly laid. The first question to be determined is that the article or material is the best for the purpose intended and that it is correctly specified and described. The second question is that of finding the best market and genuine competition and the selection of the concern from whom to buy.

Price is a matter of insignificance if these 2 fundamentals have not been properly determined. It is self-evident that an article of small utilitarian value has a correspondingly small financial value. And a low price from a vendor who did not maintain quality or failed to give delivery as needed might prove to be a very high price. When, however, these 2 factors have been properly determined, then price is a most important consideration.

STANDARD DEFINITIONS AND SPECIFICATIONS

TO ENABLE the purchasing agent to go into the market intelligently and buy the right articles and materials, he must be furnished with complete specifications by the engineering staff of all those purchases which require describing in detailed technical terms. A sufficient number of copies of these specifications should be kept in the files of the purchasing department, ready for use at a moment's notice. At any time a breakdown may make it necessary for the purchasing agent to buy quickly and these occasions do not permit of waiting

for specifications to be written up or of being dependent on some other department to furnish them. It is not the purpose of this article to discuss these specifications, but rather to draw attention to the betterment of the conditions connected with the buying of the almost innumerable number of small articles and supplies used in the construction, operation and maintenance of generating stations and public utilities.

From personal experience in handling large numbers of requisitions as they arrived in the purchasing department, the writer knows what confusion sometimes exists because of improper and incorrect methods of describing and specifying even the simplest article. A station foreman or a man in charge of some transmission lines or track work will send a requisition to the storekeeper, who may send another requisition to the purchasing agent. Now it not infrequently happens that these 3 men will use varying methods of specifying the same article. Quite often the purchasing agent refers back to the storekeeper and the storekeeper to the foreman for correct or better information.

This is demoralizing to the efficient and economical administration of any organization. The purchasing department cannot afford to permit uncertain definitions or ambiguous descriptions to be incorporated in requests for quotations or in orders, for if this is done the mischief is sown broadcast into the world of business. Every commercial establishment could testify to the evil effects which result from these causes. It means a considerable addition to their expenses and is a source of great trouble and annoyance.

The purchasing department is peculiarly well fitted to undertake the rectification of these conditions and this can be done by putting in force standard definitions for every article used. Some large public utility and manufacturing corporations get out in book form standard definitions for the purpose indicated. While these are excellent, they do not always completely answer the requirements and in some cases there are objections to them.

A very simple method is to use the definitions and short specifications in connection with some or one of the forms in daily use. In this way they are brought to the attention every time the article or material is ordered, and this constant visualization is so effective that it becomes second nature to describe each article correctly.

Take, for instance, the Stores perpetual inventory, the Purchase order record or Record of sources of supply. Either of these could be used for the purpose indicated. To illustrate this, the Purchase order Record has been selected. (See Fig. 1.) This is done because it is a good practice, to hand all requisitions, as they come into the purchasing department, to the clerk who keeps this record. He is able to note on them where last bought, price paid and to check the description or specification to see that it conforms to the standard practice.

These standard definitions apply to such things as carbon brushes, bolts, nuts, rivets, washers, etc., all kinds of small tools such as drills, files, hack-saw blades, etc., also supplies of every description such as oils, waste, brooms, etc. The purchasing department is familiar with the manufacturers' practice and is, therefore better fitted than any other department to enforce the standardization advocated.

There are many purchasing departments who look upon the work of deciphering ambiguous descriptions and unraveling kinks as a necessary part of the daily routine work; but this should not be so, for there is no valid reason why a foreman should describe an article one way, the storekeeper another way and the purchasing agent still another. There are far too many purchasing departments which do not exercise sufficient care to beat the requisitions into uniform and intelligent shape before going into the market entailing poor results for them and for the vendors.

These definitions or specifications may consist of only 2 or 3 words or figures. They should be short, clear and concise, but at the same time complete.

Having in good working order a system as outlined, for assuring proper definitions, the buyer is always sure of getting the exact article and material needed. He is certain when he asks for prices that bids are based on his actual requirements and he knows that there will

FIG. 2. RECORD FOR SOURCES OF SUPPLY

MATERIAL			DESCRIPTION									SPEC'N NO.
CAT. NO.	SUPPLIER	ADDRESS	FACTORY			REPUTATION						SPEC. REMARKS
			CAPACITY	LOCATION	TRANSPX FACIL.	QUALITY	KEEPING PROMISES	SHIPPING PROMPTLY	BUSINESS METHODS	FINANCIAL STANDG		

All those vendors who can render the best service to the purchasing agent should be listed on a record such as shown, and all information bearing on their capacity and ability to fill orders should be noted. A code can be formulated and used for registering some of the information. By compiling such a list as this the buyer knows he is obtaining competitive figures from the concern best able to supply his needs and he knows that when his order is placed it will have the very best attention.

be no "come backs" and no questions asked to clear up moot points and ambiguous meanings. He also has the positive assurance that all bidders are quoting for exactly the same article.

Finding the Best Market

When it has been definitely established what to buy the next question to be determined by the purchasing agent is where to buy. Finding the best market is, or should be entirely within the jurisdiction of the man who acts as purchasing agent and it should be his privilege exclusively to command and control every detail connected with the commercial end of all buying transactions. One of the most important features to consider is that of getting the right kind of competition.

This is a point which is frequently overlooked by buyers. Many purchasing agents think that, because they have a large number of manufacturers or suppliers who are ready to quote them for their requirements, they have plenty of good competition for their business. Nothing could be more fallacious. It is up to the pur-

chasing agent himself to dictate with whom he shall negotiate for prices and where he shall place his orders, and, to ensure the best results, this can be done only by a process of selection and elimination.

The manufacturers and vendors of almost any product or commodity can be segregated into those who are in a position to supply a purchaser's exact requirements and those who are not. Where proper records are not kept and requests for quotations are sent to manufacturers and suppliers in a haphazard manner and hit-or-miss principle, it is exceedingly doubtful whether the buyer will get in touch with the party who is in the best position to furnish his requirements.

A purchasing agent should be positive that he is confining his inquiries and orders to those concerns who are best fitted to supply his needs. This can be accomplished by keeping proper records. (See Fig. 2.) Considerable research work is necessary in compiling the list of vendors with whom a purchasing agent should do business; but when it is completed in good shape, it is an insurance against wasted energy and a positive protection against high prices, inferior quality and uncertain deliveries.

He obtains his protection against high prices by the knowledge that those firms quoting are the best equipped to supply exactly what he needs. He will be assured of getting the right quality because he will by a process of elimination have omitted from his list all those who are unwilling or unable to give him the standard of quality demanded. He will have cut out all those who do not keep their promises and make deliveries promptly. He must also take into consideration the location of vendors' factories or shipping points, and the transportation facilities from it, for it is not good policy to be entirely dependent on one factory or one railroad. Strikes, lockouts and freight embargoes might upset all one's calculations regarding delivery.

Every purchaser, therefore, should prepare for his own use a list of vendors with the essential related information concerning them. This can be compiled from experience in dealings with suppliers, by observations made in visits to their factories and warehouses during which it can be discerned whether they can give prompt service in an emergency, whether their shipping equipment is good and their stock adequate and well kept.

To broaden one's market, many useful names can be obtained from the advertising columns of the trade papers. Other sources for getting in touch with the right people are local chambers of commerce, and through friendship with men in all lines of business.

The Advantages to Be Derived From Improved Methods

These efficiencies in purchasing when put into practice have far-reaching influences. The benefits are not confined to the establishment doing the buying, but have a distinct influence on the economic operation of business in general. It is a common practice for buyers to send out requests for quotations with incomplete or inaccurate descriptions of the goods required or the inquiries are sent to firms who cannot supply the material. The result of this is that the expenses of all commercial establishments are greatly increased. Sometimes salesmen are sent to make inquiries; unnecessary correspondence is entailed in dealing with these instances. Ask any manufacturer or dealer what proportion of his correspondence and salesmen's time is devoted to answering and attending to inquiries from buyers from whom they receive ambiguous or loosely worded inquiries or requests for quotations on goods which they do not make. The answer would be astonishing.

This unnecessary expense must be added to the cost of the goods and eventually paid for by some buyer. The rectification of these conditions is largely in the hands of the buyers themselves and if better methods are enforced they will directly benefit. It means that the buyer and seller will be brought into more direct contact and many economic leakages in our system of doing business will be stopped. These leakages are the "transmission losses" of the commercial world.

Important Civil Service Examination

U. S. Civil Service Commission announces an examination for expert electrical and mechanical aid, on Nov. 14, to fill a vacancy at $12.48 a day, in the Bureau of Yards and Docks, Navy Department, Washington, D. C., and vacancies as they may occur in positions requiring similar qualifications. The duties of this position cover the expert maintenance and supervision of the operation of all navy-yard power plants, embracing the economical production, distribution, and utilization of electric power for manufacturing, pumping dry docks, charging submarines, and for ships undergoing repairs; compressed air for manufacturing; steam for power and central heating, and production and distribution of hydraulic power; also investigations of power plant operating conditions, tests of plants and equipment, and efficiency engineering work in connection with improvement of operating conditions and instruction of plant operatives to obtain economical operating results. The appointee will give expert advice upon, and will be held responsible for, the design of new projects for the economical production of power, in which will be included pumping plants for dry docks, power plants and distribution systems for experimental laboratory, projectile plant, armor plant, equipment for supplying power to radio stations, heating and lighting equipment for various prospective public works, such as hull-construction shops, foundries, machine shops, barracks, storehouses, offices, etc.; also upon the design and layout of extensions to present plants to provide for prospective expansion of yards and stations and the remodeling of lighting systems in existing buildings and shops.

Competitors will not be assembled for examination, but will be rated on the following subjects, which will have the relative weights indicated: Technical education, 40; experience and fitness, 60.

Graduation with a degree of mechanical engineer or electrical engineer from a college or university of recognized standing, and at least 10 yr. subsequent experience in responsible charge of the design, installation, and operation of central power plants and distribution systems for light, heat, and power, with executive experience in handling successfully large numbers of power plant employes, are prerequisites for consideration.

Persons who meet the requirements and desire this examination should at once apply for Form 1312, stating the title of the examination desired, to the U. S. Civil Service Commission, Washington, D. C.

Indicators---I

INTIMATE KNOWLEDGE OF THEIR OPERATION AND CONSTRUCTION OF VITAL IMPORTANCE TO POWER-PLANT ENGINEERS

PERFORMANCE of the working fluid within the cylinders of steam engines, gas engines, air compressors, ammonia compressors and pumps, and the workings and condition of valves and pistons therein can only be practically determined by the employment of the instrument known as the indicator. The importance of its position in the field of engineering is, therefore, evident.

Generally the indicator is used for checking valve settings, and determining the power developed in the

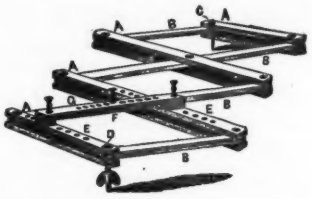


FIG. 1. PANTOGRAPH FORM OF REDUCING MOTION

cylinder. Its field of usefulness is, however, of greater extent, as will be seen by the following applications to which it is well adapted: On the steam line it will show the fluctuating pressure drop due to small or long pipes; on the exhaust pipe it will locate fluctuating excessive back pressure, whether due to small openings or exhaust pipes; on the boiler it will register pulsations due to cutoff valves; and it affords a means of checking up the pressure drop in pipes and of checking pressure gages

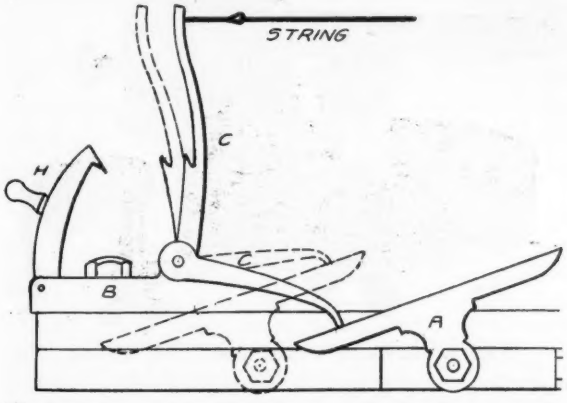


FIG. 3. REDUCING MOTION ADAPTED TO SHORT-STROKE ENGINES

for correctness. Additional use may be made of the diagrams, which when transferred to logarithmically ruled paper, furnish a means of determining the steam used, cylinder clearance and leakage to and from the cylinder.

In general the indicator consists of a cylinder containing a movable piston on which the pressure of the working fluid acts against a calibrated spring; a drum making nearly one complete revolution for every stroke of the engine, compressor or pump, and upon which is mounted the paper receiving the record of performance; and an intermediary mechanism by means of which the travel of the indicator piston at all points of the stroke of the engine or pump is recorded upon the paper on the drum. Motion is imparted to the recording drum from the crosshead through the medium of some form of reducing motion whereby a fixed ratio is established between the length of stroke and the length of the recorded diagram.

DETAILS OF CONSTRUCTION

IN MOST cases the cylinder is removable, and is made of brass or bronze, excepting when employed in connection with ammonia compressors, in which case steel is used; it is generally surrounded by a jacket of the working fluid so as to avoid as far as possible condensa-

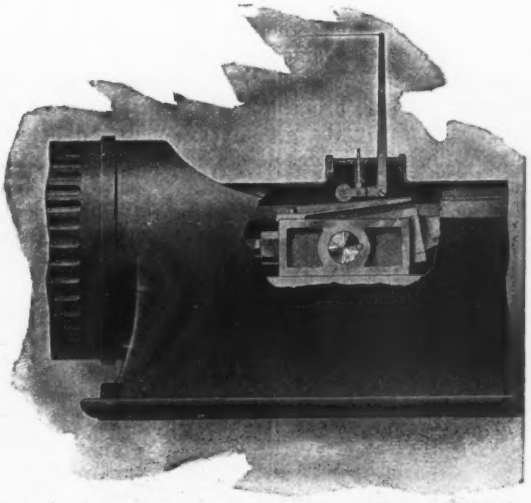


FIG. 2. AMERICAN ENGINE & ELECTRIC CO.'S REDUCING MOTION

tion due to radiation. Pistons which are either of brass composition or steel are usually made in the form of a thin shell as light in weight as is consistent with proper strength and having sectional areas of 1 sq. in., ½ sq. in. or ¼ sq. in., the latter being generally employed for high pressures such as are encountered in gas engines and hydraulic work.

IT is necessary that all moving parts be as far as possible free from friction and at the same time light in weight, but sufficiently strong to perform their work with a minimum of wear and without affecting their alinement. Lightness of parts is also essential to avoid the distorting effects of inertia on the diagram.

While the majority of indicators employ spirally wound, single or double springs of the enclosed or exposed types, flat springs such as found in the Bachelder indicator, described later, have been used. Early

makes of indicators employed enclosed springs exclusively, but with the introduction of high-pressure and superheated steam and the internal combustion engine, has come the exposed spring to eliminate the effects on the spring of the accompanying high temperatures. Nearly all modern indicators are now made in both the inside and outside-spring types, the individual design being changed slightly to accommodate the location of the spring. When working, nearly all enclosed springs are

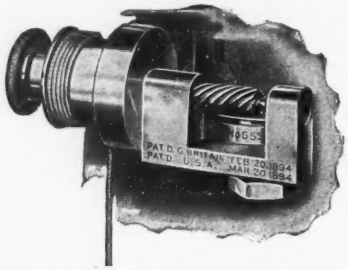


FIG. 4. THE HOUGHTALING REDUCING MOTION

subject to compression, while exposed springs may be under compression or tension depending upon the relative location of the parallel-motion mechanism.

While some indicator manufacturers employ springs wound in double coils, the majority of such springs appear to be of the single-coil type, their advocates claiming that with the former style of winding any variation from the true proportional compression is magnified many times by the pencil movement and because, as they claim, such springs do not at best give more than 2 in. of reliable pencil movement. Then again, those employing the single-coil type claim for them the absence of eccentricity and unnecessary weight producing friction or error in the operation of the instrument.

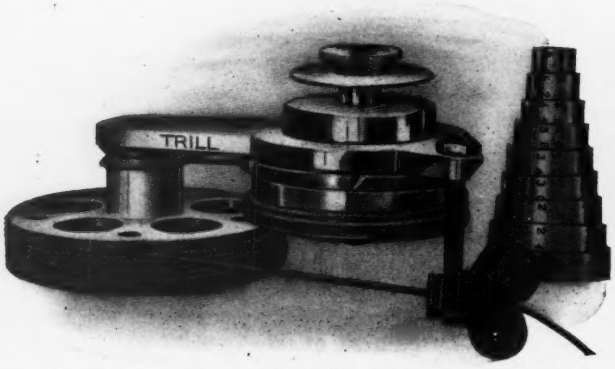


FIG. 5. TRILL FAULTLESS REDUCING MOTION AND BUSHINGS

As a rule, the paper drum is made of seamless brass tubing with closed reinforced top having a diameter of from 1½ to 2 in. and capable of holding a chart about 3 in. high. Steel clips hold the paper closely to the drum.

Forward motion is given the drum by a cord attached to the reducing motion mechanism or, as is the case in some types, directly by this mechanism. Return motion is obtained by an enclosed spiral wire or leaf spring, and movement of the drum may be stopped by means of a detent motion consisting of a handle attached to a pawl engaging or disengaging ratchet teeth cut on the bottom flange of the drum carrier. Another method of drum control consists of a knurled nut at the top end of the drum shaft, the tightening of which causes the drum to grip the bottom flange; loosening this nut releases the grip of the drum and thereby allows it to be stopped.

Motion of the pencil point parallel to the drum axis is in the majority of indicators obtained by the use of the Thompson type of pencil movement, such as employed in the Trill and other makes of indicators to be described in a later article. In the Tabor indicator, a somewhat different arrangement is employed, parallel motion being accomplished by means of a stationary guide plate containing a mathematically-plotted curved slot.

Best results are always obtained by the use of a hard lead pencil bearing lightly upon the paper; for exceedingly accurate work, some manufacturers equip their instruments with silver or brass pencil points for use with cards having metalized surfaces, which give a fine, distinct black outline of the diagram.

Indicator Control

In order to provide sufficient working clearance around the paper drum, the entire parallel-motion mechanism is mounted upon a sleeve surrounding the cylinder, thereby allowing the pencil arm to be swung to and from the card as required. Ordinarily this part of the instrument is manually operated by means of a small handle attached to the side of the sleeve; but where

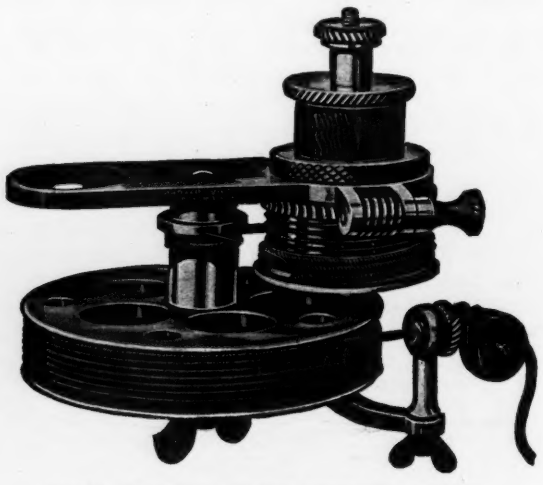


FIG. 6. IMPROVED VICTOR REDUCING WHEEL

remote control is desired or 2 or more indicators are to be operated simultaneously, as when conducting tests on compound or triple-expansion engines, electric or pneumatic control is employed.

In the case of electric control, the pencil arm is operated by a small 2-pole electro-magnet receiving current from a battery of 2 or more cells; pneumatically controlled pencil movements are operated by rubber bulbs, the air acting against small plungers in a manner similar to that employed to open and close the shutters of cameras.

Continuous Records

Many times when conducting engine tests where it may be desirable to have a card for every stroke, the available time between taking records is too short to allow a change of cards. To overcome this difficulty, continuous-card indicators have been developed.

The usual arrangement for this purpose consists of providing 2 drums, one of which carries a roll of paper of the length required, and a second drum over which this paper is drawn and on which the diagram is traced. When the indicator is started, the paper from the roll automatically feeds onto the tracing cylinder and a card is secured for every stroke of the engine, or, if it is not desired to indicate every stroke, the travel of the paper may be stopped and but a single card taken. As soon as a single card or a series of cards is obtained, the record may be torn off and examined.

Continuous indicator records are of special value when indicating gas engines, as the mixture is liable to change, or several strokes may be missed, or back firing may occur.

Reducing Motions

With the introduction of the steam-engine indicator came the problem of providing a suitable reducing motion. At first, various crude contrivances were devised, which to some extent accomplished the desired results, but proved unreliable for work requiring any degree of accuracy.

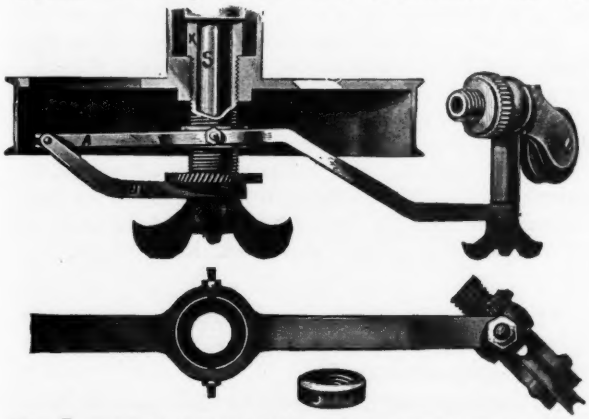


FIG. 7. SECTION OF IMPROVED VICTOR REDUCING WHEEL SHOWING CONSTRUCTION OF CORD-GUIDING MECHANISM

An original form of reducing motion and one still occasionally found in use on slow-speed and long-stroke Corliss and slide-valve engines, is the pantograph or "lazy tongs", shown in Fig. 1. In this particular pantograph, the long levers are of cherry, 16 in. between centers and 1⅛ by 5/16 in. in section. Hitch strap G is arranged so that it may be shifted in holes E, thus bringing hitch pole F in line with pivots C and D. A vertical hole must be provided in the engine crosshead into which pivot C can be dropped while a post placed near the guide and having a socket at the top for the reception of pivot D acts as a stationary support. This latter socket must be level with and directly opposite the crosshead socket when at mid stroke.

The indicator cord is hooked to center peg F and the stationary support should be set at such a distance from the guides that the cord will lead off parallel with the guides; otherwise a guide pulley will be necessary.

When the pantograph is in motion, every point on a line cutting C-D has a true motion parallel with the guide and varies in distance from nothing at D to length of stroke at C. It is only necessary to hitch the cord at a point on this line to give the required amount of motion to the cord. This cord will be near D and within the range of adjustment of strip G.

A type of reducing motion adapted by the American Engine & Electric Co. for use on automatic high-speed engines is shown in Fig. 2. The crosshead is fitted with an inclined plane surface upon which rides a small wheel attached to the short arm of a bell crank. Attached to the end of the long arm of this crank is the cord leading to the indicator, and as the crosshead travels back and forth, the inclined plane being in continuous contact with the roller, causes the bell crank to swing upon its supporting pivot and through the medium of the cord imparts motion to the paper drum of the indicator. By means of the spring shown, the roller is caused to remain in contact with the inclined plane at all points of the stroke.

In Fig. 3, is shown another reducing-motion mechanism good for short strokes. Inclined member A bolted to the crosshead raises the horizontal arm of bell crank C, which in turn imparts the desired motion to the indicator cord through the medium of the vertical arm. The degree of motion given the bell crank may be varied by changing the inclination of member A while H holds the foot of the horizontal arm of bell crank C off member A and stops the instrument without the necessity of unhooking the cord.

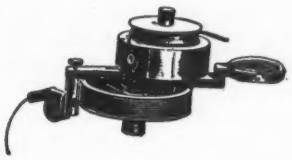


FIG. 8. AMERICAN IDEAL REDUCING WHEEL

The Houghtaling reducing motion used in connection with the Tabor indicator is composed of a supporting base provided with short standards that form bearing for the worm shaft on which the flanged pulley is rotated, the outer bearing being a pivot which receives the entire thrust of the shaft. It is connected directly to the indicator upon the projecting arm supporting the paper drum, and the worm shaft directly engages a gear on the drum carriage. Connected with the base piece is a spring case containing a special spiral steel spring the function of which is to return the pulley to its starting point after it has been revolved in one direction by the forward movement of the engine crosshead. On the extreme end of the worm shaft is secured a collar through which a clutch pin freely slides, one end being securely fastened to a swivel thumb piece for operating it. To the pulley, which runs independently on the worm shaft and has on its outside a clutch-shaped hub, is connected the cord from the crosshead.

The pulley is independently rotated back and forth on the worm shaft, thereby making it unnecessary to unhook the cord from the crosshead when cards are being placed on the paper drum. The drum is rotated forward by means of the pulley through its worm shaft

engaging the worm gear on the paper drum carriage, and in the reverse direction by the action of its own spring.

Size of pulley used with the Houghtaling reducing motion depends upon the length of engine stroke.

Another form of reducing motion consists of 2 wheels of different diameters on the same shaft which is fastened to the engine bed or floor. A cord from the crosshead runs on the rim of the larger wheel, while the cord imparting motion to the paper drum is taken from the smaller wheel. By varying the diameters of the wheels, any desired length of diagram may be obtained. For high rotative speeds, a strong spring is used to overcome the inertia of the wheel.

Of late years, such reducing wheels and motions have been attached directly to the indicator as exemplified in the Trill Faultless Reducing Wheel which is said to give the fully required number of reduction ratios covering any piston travel from 6 in. to 5 ft., with cord hooked direct to crosshead.

Two distinct stages of reduction are obtainable by the use of this reducing motion. One stage is by the employment of the 2 right-hand wheels, Fig. 5; the second stage is secured by combining the reduction given by the lower left-hand cord wheel.

The lower right-hand wheel containing the recoil spring is 2½ in. in diameter. The upper wheel mounted on the same shaft and carrying the cord to the proper drum is made up of a nest of aluminum bushings giving 9 distinct ratios of reduction, covering any stroke from 6 to 20 in. The bushings are inserted on the central shaft and held in place by a circular retaining plate and knurled nut. For high-speed, short-stroke engines, but one reduction is required; for longer strokes, the second stage of reduction is added by the use of the large cord wheel. The cord from the crosshead is first carried over this cord wheel, which reduces the motion in the ratio of 3½ to 1 before it is transmitted to the wheel containing the recoil spring. This together with reductions obtained by the bushings allows a total of 18 possible adjustments covering piston strokes of from 6 in. to 5 ft.

Bushings are changed by merely unscrewing the knurled nut and removing the cover plate which not only keeps the bushings from working loose but also acts as a shroud to keep the cord in place.

A distinctive feature of the Improved Victor Reducing Wheel, Fig. 6, is the cord-guiding mechanism employed. As shown in section in Fig. 7, the cord wheel revolves on a polished steel spindle S and is fitted with a threaded hub K, the whole being held in place by a thumb nut. This nut also serves to hold a short support for forked arm A, which at its center is connected to a nut riding on hub K and to the opposite end of which is attached the cord guide and pulley. It is, therefore, evident that as the cord wheel makes one revolution, the cord guide will be raised or lowered a distance equal to the pitch of the thread cut on hub K, which is approximately equal to the thickness of the cord. Thus the cord may be led in any direction, and still wind smoothly on the wheel, coil to coil. Spring adjustment is obtained by the spring tension device shown at the right of Fig. 6.

The American Ideal Reducing Wheel is made up of a cord wheel and a spring wheel mounted, as shown in Fig. 8, upon a solid bracket. The mechanism is made of aluminum, brass and steel and the coil spring is encased separately and connected by a 3 to 1 gear with the cord-wheel spindle. Reduction adjustments are accomplished by means of bushings which are furnished for strokes from 10 to 72 in.

American Ass'n of Engineers Meeting

ADDRESSING the American Association of Engineers at its second annual Booster dinner, on "Marketing Engineering Ability," Professor C. F. Harding, of Purdue University, emphasized the importance of using simple, understandable English in writing specifications, reports, and other engineering literature. Business men, he said, are too often confused and disgusted with an overabundance of needless and meaningless technical phrases.

In the discussion which followed, Garrison Babcock, National President of the Association, outlined the possibilities and purposes of the organization. Other speakers were: City Engineer John Erickson, D. H. Maury, and J. N. Lewis.

Over 300 members and guests were seated at the dinner, which was held on Oct. 6 at the City Club in Chicago.

Having for its object the elevation of the standard of ethics of the engineering profession, and the promotion of economic and social welfare of engineers throughout the United States, this association has had a remarkable growth. In September, 1915, it had but 100 members; the present enrollment is over 1200.

PLANS FOR America's Electrical Week are going forward steadily, and are being given attractive and diverse forms in many different cities.

In Lexington, Ky., all public buildings will be flood lighted during the week, illustrated lectures will be given to the school children, special discounts given on house-wiring done during the week, and special rates made for appliances bought.

At Syracuse, N. Y., there will be an Electrical Parade, including pleasure and business vehicles and tractors, with special street illuminations.

Louisville, Ky., is planning an Electrical Exposition in the Armory, with special high-class entertainment during the week, and a campaign to induce merchants to use decorative lighting.

Cleveland, O., will give a special display of heating devices and other domestic appliances, and a committee is working to have all window displays bear particularly on the purpose of Electrical Week.

The effort in Salt Lake City, Denver, and throughout the mountain states will be to interest housewives in electrically operated appliances for the home. In the southern cities, including Birmingham, Atlanta and Charlotte, special parades of electrical vehicles are planned, including floats and pageant features, and special displays by all merchants, both those handling electrical apparatus and others.

Electrical Machinery and Appliances

For Generating, Transmitting and Using Current

The Vibrating Rectifier Defined

EXPLANATION OF OPERATING PRINCIPLES AND WIRING OF SIMPLE DEVICE FOR CHARGING BATTERIES FROM A.C. CIRCUIT. BY J. C. GRINDELL

THIS device, which has come into general use in the automobile field for reviving starting, lighting and ignition batteries is little understood. Its purpose, rectifying alternating current to direct current at the proper value for charging batteries, is usually accepted without censure.

To be properly handled and to diagnose any trouble that may arise, it must be thoroughly understood. In the first place, the mechanical rectifier proper consists of a transformer, one or more pairs of vibrating armatures and regulating resistance.

The principle of the device is an electrically-operated vibrating switch, which reverses the connection of the alternating-current line to the battery in synchronism with the alternations of the current, this reversing

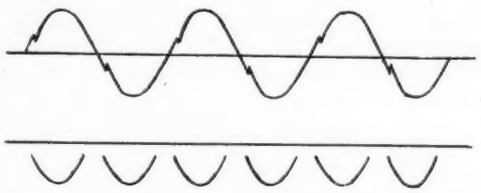


FIG. 1. OSCILLOGRAM OF IMPRESSED VOLTAGE AND CHARGING CURRENT. THE SHARP BREAK IN THE VOLTAGE WAVE DOES NOT EXIST IN THE IMPRESSED WAVE, BUT IS CAUSED BY THE DROP IN POTENTIAL AT THE INSTANT THE CURRENT STARTS

action being accomplished at the moment when the current flow is zero. The rectification is thus accomplished without sparking at the contacts, and results in the delivery to the battery of an intermittent, pulsating current uniform in direction. When thus supplied with unidirectional current, the battery is charged exactly as though a constant voltage direct current were applied. The shape of the rectified current wave and its relation to the original alternating current wave are indicated in Fig. 1.

The principle on which the device operates can be best understood by reference to Fig. 2, where it will be seen that the movement of the vibrating switch is controlled by magnetic means. The small 2-winding transformer serves to reduce the alternating current line voltage to the proper value for charging battery cells. Across ½ of the low voltage winding are connected the 2 alternating-current magnets, which, while electrically in series, are magnetically in opposition to each other. That is, each present the same magnetic polarity to the pivoted armature at any given instant. During ½ wave of the alternating current, each magnet presents, say, a north pole to the armature, while during the next half wave, each presents a south pole. There is a winding upon the armature also which receives direct current from the battery being charged. This causes one pole of the armature to be north and the other to be south, continuously, so long as the battery remains connected to the rectifier. Inasmuch, as a north magnetic pole tends

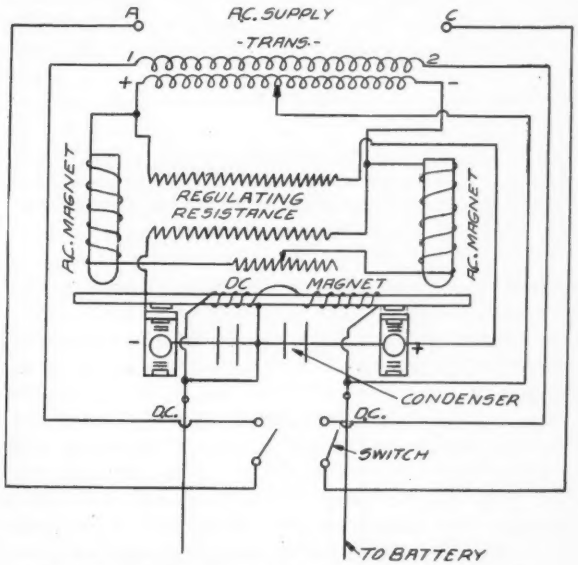


FIG. 2. WIRING DIAGRAM OF VIBRATING RECTIFIER

to attract a south and repel a north pole, the alternating current magnets attract one end of the armature and repel the other at a given instant. Each time the alternating current reverses the opposite end of the armature is attracted and it swings accordingly on its pivot support in synchronism with the alternations of the current. The amplitude of vibration is controlled by springs at each end of the armature and these likewise serve to render the vibrations smooth, uniform and positive. The moving contacts are themselves mounted on springs whose compression, when contact is made, prevents any tendency to bounce, and likewise allows the contacts to remain together the length of time necessary for the proper charging current to flow. The armature carries

near each end a platinum contact opposite each of which is mounted a platinum tipped screw. As the armature vibrates contact is made, first on one side and then on the other. As shown in the diagram, the two ends of the low voltage winding of the transformer are connected to the two contact screws, while the middle point of the armature is connected to one of the two binding posts which serve as terminals for the connection of the battery to be charged. The other battery binding post is connected to the middle or "neutral" point of the low voltage winding of the transformer. Accordingly, when the armature is attracted in one direction, the current flows from one end of the transformer secondary across the platinum contacts that are then together, out through the middle point of the armature into the battery, and back to the neutral of the transformer. When the alternating current reverses and the armature is attracted the other way, the current flows from the other end of the transformer secondary winding across the other pair of platinum contacts and thence through the battery in the same direction as before. This action gives the intermittent, unidirectional current through the battery.

A valuable feature of this arrangement is that it makes no difference how the battery is connected to the rectifier and no attention need be paid to polarity, as

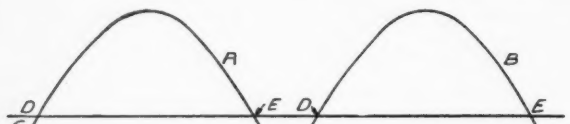


FIG. 3. DIAGRAM OF RECTIFIER ALTERNATING VOLTAGE WAVE AND BATTERY CURRENT

the outfit will automatically deliver current to the battery in the right direction, no matter which way it is connected, since if the battery connection is reversed, the polarity of the direct-current armature is thereby also reversed.

To be a success, a vibrating rectifier must not only deliver direct current, but it must do it practically without sparking; otherwise, long life of contacts and freedom from the necessity of readjustments will not be obtained. To accomplish this, the motion of the armature must be so timed as to break contact just at the right instant, that is, when the current is passing through zero, as shown in Fig. 3, where A is the wave of alternating voltage and B shows the second half wave inverted or "rectified." C is the voltage of the battery and O is the line of zero voltage. Only that portion of the alternating current wave which lies above the line of battery voltage is effective in charging the battery. If the rectifier is to operate properly, it should make contact at point D or some higher point on the alternating current wave and break contact at point E only. If it makes contact at any point between zero and D, a reverse current will flow from the battery into the rectifier, tending to discharge the battery. If it makes contact at D, or some higher point, the current will flow into the battery as desired. The effect of making contact too soon, is, therefore, to reduce the output of the rectifier by allowing an initial reverse current to flow that partially nullifies the good effect of the later current in the right direction. The effect of making contact late is to reduce the output by not utilizing all of the available alternating current wave. Neither making contact early or late, however, has any effect on the sparking, which is dependent only on the time of breaking contact. If the break occurs just at the point E, the current at that instant will be zero and no sparks will occur when the contacts separate. If, however, the break occurs at some point above E, the current will still be flowing into the battery, or if at some point below E it will have reversed and will be flowing out of the battery, and in either case, sparking will result. Accordingly, it is necessary that the rectifier be adjusted by the manufacturers, so as to break contact when the current is zero and so operate sparklessly. But to make assurance doubly sure, and to guard against unusual conditions, suitable condensers are connected across each pair of contacts, as has long been the practice on induction coils, for instance, to absorb any sudden rush of current when the contacts open and so prevent what little sparking might occur. During the period between E and the next succeeding D, the vibrator has broken contact on one side and has not yet made contact on the other. As both pairs of contacts are, therefore, open, there is no current flowing in the battery. This period of zero charging current is plainly shown in the oscillogram, Fig. 1.

If the rectifier is used on an alternating-current circuit, whose wave form differs very much from a sine wave, it may be necessary to change the adjustment slightly to eliminate sparking. This is because the time of zero current may come a little earlier or later than in the corresponding sine wave. If this involved any delicate change of springs or contacts, such an adjustment would be an undesirable, even though a necessary, feature; but fortunately, it is simply necessary to slide a contact along a small resistance mounted in an easily accessible place at the rear of the vibrator until the point is reached where sparking has ceased. This resistance is connected in series with the stationary alternating current magnets and serves to shift their phase angle, that is, to vary slightly the time at which they reach their maximum strength during each half wave of the alternating current, and accordingly, the time at which the contacts break. This single adjustment is very simple and can be used to make up for wearing away of the contacts as well as for adapting the operation to unusual wave shapes.

The rectifier is put in operation simply by screwing the adjustment plug into a lamp socket, connecting the rectifier to the battery (paying no attention to polarity) and turning on the switch. The rectifier will start up automatically and in case the line voltage is interrupted during charge, it will stop on open circuit. There is thus no possibility of the battery discharging back through the rectifier, and no elaborate special cut-out switches are necessary to give this protection. When the line voltage comes on again, the rectifier re-starts automatically.

FOR MERCURY, the freezing point, as recently redetermined by the U. S. Bureau of Standards, is at —39 deg. C. (—38.2 deg. F.).

Underground Distributing Systems*

SUGGESTIONS FOR THE DESIGN OF A SUCCESSFUL SYSTEM. BY G. J. NEWTON

UNDERGROUND distribution is the ultimate solution of the distribution problem that confronts every electric light and power company operating in progressive towns and cities. The excessive cost of this class of construction, as compared with aerial construction, and the permanent nature of the system, warrant a careful study of the conditions and justify a reasonable expense in the development of suitable plans for the system.

Economy of distribution is equally as important as economy of production, particularly at the present time, when virtually all public utility companies are regulated, to a greater or less extent, by state or municipal commissions. First cost is not, therefore the only factor that should be considered, as economical operation and reliability of service are equally as important in the financial success and growth of the business.

Except in the large companies, there is probably no branch of the business that has been given less thought and study than underground work; in many cases the principal object evidently has been to get the wires out of sight at the least possible expense, no attempt being made to improve the system of distribution and little or no regard for the future development of this class of service.

When properly designed, installed, and maintained, the operation of an underground system guarantees the most reliable and efficient service of any method of distribution ever employed; the financial benefit, directly due to this class of service is, in many cases, a proof of the wisdom of its installation.

In designing an underground distribution system there is one important fact that must always be considered—the system should be designed to serve the entire district that can reasonably be expected ever to require this class of service. Such a design permits of a systematic scheme being developed for the whole district, uniform methods of construction, and standardization of equipment.

If this method is followed it is then possible to install any section, from time to time as the service demands, and each completed section will form a part of the whole general scheme and eventually develop into a system rather than a collection of more or less useful sections of conduit.

Securing an accurate load record for each consumer in the proposed underground district should be the first step in designing an underground distribution system, and where there is a large power load in the district it is advisable to make separate records for the lighting and power loads.

A careful inspection should be made of each building to determine the most suitable location for the new underground lateral in order to reduce the cost of changing the inside wiring as much as possible. Except in the case of very heavy loads or consumers where emergency service must be provided for, it is advisable to supply all of the consumers in a building from one lighting and one power lateral; this reduces the number of laterals, handholes, and fuse boxes and permits using the least amount of copper by taking advantage of the diversity of a group of consumers.

The load maps for each system should show the total load, both in the underground district and outside of it, that is to be supplied by cables in the conduit system from the power house so that ample conduit space can be provided and the most suitable routes and sizes of feeders determined.

Having the lighting and power loads and a map showing the street light system, the next step is to determine the most suitable plan of distribution to be adopted, this may be called the critical point in the design of a distribution system, for on the decision depends not only the first cost of the installation, but the reliable, efficient and economical operation of the distribution system.

There are two general schemes of distribution:

1. To supply the whole city from one power house.
2. Divide the city into districts and supply each from substations, or rather from the power house and substations.

In many of the older systems the first method was used and a large number of ducts were installed, in one trench from the power house, to serve the whole city, or at least that portion that was to be supplied by underground eventually. This necessitated providing a large number of spare ducts, a large percentage of which remained idle for years and not infrequently resulted in too many ducts in some places and too few in others.

Not only was the first cost of such a system excessive but the manholes were almost invariably too small to accommodate the number of cables that could have been installed in all of the ducts had there ever been use for them. The most serious objection to this plan is that the losses due to the heating of so many cables in one conduit run are excessive and materially reduce the carrying capacity of the cables, particularly in cables occupying the inner ducts.

Another serious objection to this method is that a burn-out on one cable is almost certain to damage adjacent cables and cause interruption of service over a considerable area. Faults on underground systems usually affect more consumers than on an overhead system and require more time to repair, therefore, no system should be considered that does not permit being sectionalized and have reasonable emergency facilities provided for restoring service with the least possible delay.

Objections to the first plan, as stated above, preclude its adoption except in very small cities where the area to be served by underground distribution is limited, and the total number of ducts installed in one trench will not be excessive.

When properly designed, the second method of distribution avoids all of the objectionable features of the

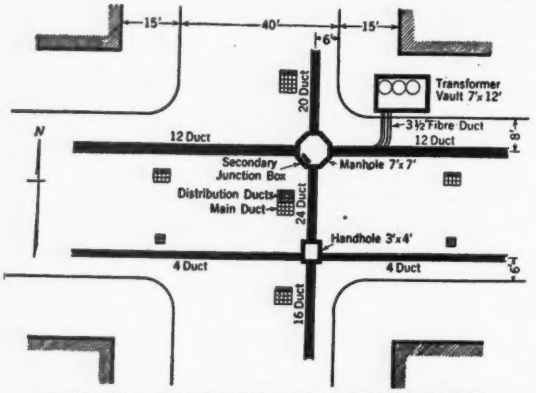
*From a paper read before the Association of Iron and Steel Electrical Engineers.

first method and is particularly adapted to the modern practice of installing substations supplied by high-tension feeders, as each district is practically operated separate from the others and with suitable emergency feeders and switching equipment permits each district to assist the others in case of necessity.

After making the load maps for the lighting and power systems and also a map showing the location of the street lights, it is a good plan to lay out first the street light circuits, for assuming that all wires in the district must be placed underground it is evident that conduit must be installed to reach every light.

Location of the street lights is determined by the city authorities and can seldom be altered enough to change materially the conduit arrangement, therefore, by designing this system first it will give a general idea of where the conduit *must* be installed and keeping this plan in mind it is frequently possible to arrange the secondary mains so as to utilize the same routes (particularly in alleys and the less important streets) so as to avoid considerable conduit construction.

The proposed location of the laterals in each building should be shown on the plan for the secondary systems



MANHOLE AND TRANSFORMER ARRANGEMENT

for light and power. A study of these locations, together with the street light conduit layout will often show where slight changes in one or the other will permit considerable saving, even when changing some laterals will increase the cost of inside wiring.

Owing to the fact that the grouping of consumers, in a district, will usually be different on an underground system than it was on the original overhead system, it is almost impossible to determine accurately what the demand and diversity factors will be for the new system.

A distribution system for either lighting or power usually consists of the following subdivisions:

Primary feeders to centers of distribution.
Secondary feeders supplying the transformers.
Secondary mains supplying the service laterals.
Service laterals supplying the consumers.

In small systems the secondary feeders are not required, as the transformers are connected directly to the primary feeders.

Cable sizes for the laterals are easily determined; the principal object is to restrict the number of sizes of cable as much as possible, using about 3 sizes for the whole system, and if possible, making the largest size used for laterals the same as one of the sizes used for secondary mains.

In order that one size and style of cable can be used for all of the feeders, the load in the district should be divided as equally as possible into a suitable number of distribution centers, as this permits standardizing the equipment and requires less cable being kept in stock for emergency purposes.

Feeders, constructed usually of small cable and having few or no taps on them, can easily be replaced by larger cable and the old cable is in sufficient lengths to be used elsewhere. Instead of installing a larger cable to replace a loaded one it is generally better to install an additional feeder to another center of distribution, using the standard size of cable.

Where the requirements of the system demand the use of 2-conductor cable it is advisable to have it made up in round form instead of the flat, or figure 8 style, as it is almost impossible to train this latter style without kinking it.

A careful study of the conditions under which underground distribution systems operate, particularly in medium size or smaller cities, has convinced the writer that the safest guarantee of reliable, efficient, and economical operation is to install cable and equipment, as far as the conditions will permit, under the following general rules.

For service laterals, use either cambric or rubber insulated cable, spliced directly to the secondary mains, and terminated in water-tight fuse boxes on the consumer's property. (The number of laterals taken out at one splice will depend on the system; for single-conductor cables 4 laterals can be taken out, but 2 is about the limit where 3 conductor mains and laterals are used.)

Secondary mains should be cables of ample size to provide for all the growth that can reasonably be expected. Use either varnished cambric or rubber insulated cable for all secondary work where cables terminate in subway equipment.

Primary feeders derive the most benefit from the diversity factor, are comparatively long lengths, and have few taps on them, therefore are less subject to damage than the rest of the cables and are easily replaced with small financial loss. Small reserve capacity is all that need be provided for this class of cables.

Paper insulated cable can be used to advantage frequently at considerable saving providing that the ends are properly terminated in compound-filled potheads or varnished cambric or rubber insulated tails used for connecting to the equipment. Its use is not favored on distribution systems, except in cases where the emergency facilities are such that the failure of a feeder cannot cause a serious interruption to the service.

In small companies, where competent cable men are not always available, the use of paper insulated cable on the distribution system is not advisable; it is, however, well suited for high-tension feeders and tie-lines.

Subway Equipment

Due to the liability of being submerged occasionally and the limited space usually available, for its installation, subway equipment is probably the most prolific cause of trouble on underground distribution systems, and the greatest care must be used in selecting and installing it.

Provision of reliable sewer connections to all manholes and vaults in which subway equipment is located, is the best insurance against trouble from this cause. Separate the primary and secondary equipment by placing the transformers, primary fuses and switches in a vault (preferably located under the sidewalk adjacent to the manhole in which the secondary junction boxes are located.) This arrangement reduces the length of the secondary mains, which are usually large, expensive cable, and lessens the liability of a burnout on the primary equipment damaging the secondary network.

Placing the vaults under the sidewalk affords more room than it is possible to secure in the street and there is less liability of the vaults being flooded from surface water. This method of construction is more expensive than placing all of the equipment in the manholes, but the added security is well worth the expense on an important installation.

Subway transformers should not be set on the floor of the vault, but should be raised so that the air can circulate under and around them. Where more than 200 kw. of transformer capacity has to be installed in one vault it is advisable to provide ventilating pipes from the vault to a pole or side of a nearby building.

Subway junction and fuse boxes should not have slate or marble bases, but use ebonite or similar material that will not absorb moisture. All boxes should be subjected to an insulation test before being installed. Barriers should be provided between terminals of opposite polarity.

Iron work of all subway equipment should be permanently grounded to a reliable ground rod, plate, or if possible, to the city water pipe system. In large vaults, where there is considerable equipment, at least 2 ground connections should be provided.

Installing Cable

Assuming that all cable has passed the usual factory test, it is seldom necessary to subject it to another test before being installed unless there is some evidence that it has been damaged in transit. The conditions under which the cable is purchased and installed will, however, generally decide this point.

Use skids in loading and unloading reels, never drop them off the truck. Place reels as near the point where they are to be used as possible. When reels must be left on the street for some time they should be securely blocked or preferably wired to a pole to prevent their being rolled about. Care should be taken not to place reels where they will interfere with hydrants, or obstruct manholes, water gates or traffic.

Never handle paper insulated cable when it is cold. In cold weather it should be kept in a warm place until it is to be installed. Paper cable should not be bent shorter than 8 times its diameter and should be warmed before bending.

Always provide sufficient men and power to handle cable safely during installation, when the cable is started in the conduit try to maintain an even steady rate of pulling. For heavy cable it is advisable to use grease or powdered soapstone.

Ends of cables should be kept sealed until ready to be spliced. Cables should not be left hanging from the duct mouth, but should be supported on hangers with as little bending as possible. The final bending and training of cables should be done by the splicer when joining the sections.

When installing a new system, all lengths of cable should be bonded together temporarily as soon as they are installed. As soon as the cable system is completely connected up tests for electrolysis should be made of the whole system and proper measures taken to protect the cables in case of necessity.

The arrangement of cables and equipment in the manholes and vaults must be carefully planned to secure neatness and ample space in which to work and operate the equipment with safety.

All cables and equipment should be plainly marked showing the operating voltage and system it is used for. Where single conductor cables are used on 3-phase circuits they should be distinguished by different colors, which will prevent mistakes in making changes, as only cables of like colors should be connected together.

While it is admitted that it is impossible to install a system that will be entirely free from trouble, it is possible, by carefully designing the system to prevent many of the faults that are a constant source of trouble on many systems.

In the booth devoted to educational work by Newark, N. J., Association, at the recent Minneapolis Convention, an interesting collection of lists and photographs showed a method which might well be adopted as standard for such purposes by other associations. The samples shown were mounted on bristol board about 17 by 22 in. and included lists of books or technical subjects to be found in the Newark Public Library, recommended books for study and reading, including general culture as well as technical specialties, photographs of prominent engineers in the power plant field, interior and exterior views of noted plants, and pamphlets issued by various national and state bureaus and engineering societies giving valuable technical information.

In the system employed by the association, the material is all filed in vertical steel files, carefully indexed, and, when wanted for talks or lectures is mounted on frames which are carried by standards so that both sides may be used. Any number of frames may thus be arranged in a line or semicircle as may be most convenient so that reference can be had to all at the same time, or the frames may be placed on a single standard, one after another in a consecutive series. This gives an inexpensive, flexible system, keeping all data readily available for reference, and quickly arranged for special use at any meeting.

Melstone, Mont., is to have an electric lighting plant to be run in connection with the water system, according to the action taken by the city council. It is planned to have the plant in operation by Dec. 1 of this year. The city will purchase the materials required and then let a contract for the installation work. No protests by Melstone property owners were made against the action of the council. Besides furnishing light for the business establishments and residences, there will be sufficient power to maintain light on all street corners.

Insuluminum

TESTS OF A NEW METAL WITH HEAT RESISTING QUALITIES. BY ROBERT JUNE

ONE OF the interesting, new things which the research laboratories of the General Electric Co. at Schenectady have developed in the past few years is a process for impregnating iron and steel, with an aluminum alloy. The resulting material is a rich ferro-aluminum, of great hardness, and possessing heat-resisting qualities much in excess of iron and steel, which has been given the registered trade-name, "Insuluminum." It is a discovery of the first importance. Since the close of the bronze age iron has been used for ovens and tools of every kind for all temperatures up to dull red; but for higher temperatures no cheap metal has been available.

Manufacturers and users of a wide range of equipment that has to meet unusual thermal conditions have been quick to seize the opportunity of increasing the effectiveness and durability of their units by the use of material treated by this new process. Soon after

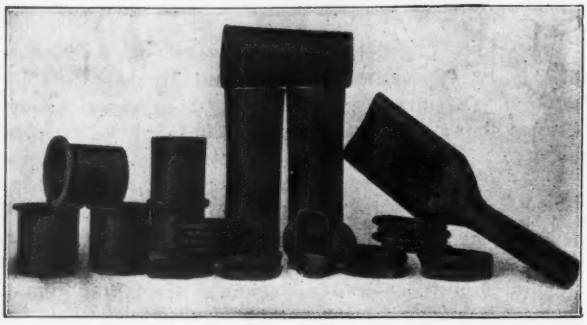


FIG. 1. STANDARD BOILER TUBE TESTS ON CALORIZED-METAL TUBES

the process was announced the Diamond Power Specialty Co.'s engineers investigated the new material, by mechanical and thermal tests and trial installations of soot blower units in all the different types of water tube boilers. A year ago the Diamond Co. secured sole right as lessee from the General Electric Co. to the use of this process in the manufacture of soot blowers and other power plant equipment.

The Insuluminum units were placed at points in the passes where the temperature ranged from 1800 to 2000 deg. F. (985 to 1095 deg. C.). The need of blowers at these locations had long been recognized, but their application had been considered impracticable. Performances of the units were watched with keen interest for months. In the end it was proved that they met such hard service conditions fully. There was no sign of scaling or disintegration from the long exposures to combustion gases at the high temperatures obtaining.

Hundreds of successful Insuluminum installations have been made in the past year, and are now giving satisfaction in all types of water-tube boilers, including Babcock & Wilcox, McNeal, Badenhausen, Union Iron Works, Stirling, Rust, Wickes and Erie City.

The originator of the new method, having in mind the heat-resisting qualities of the product, called the treatment "Calorizing." The essential point of this process is that the insulating material enters into intimate association with the metal to be treated, so that the whole outer region of the body affected changes in

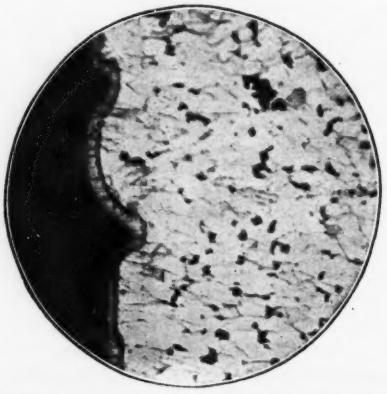


FIG. 2. OUTSIDE BEND OF FLATTENING TEST OF CALORIZED TUBE, MICROPHOTOGRAPHS BY NATIONAL TUBE CO.

composition. A homogeneous alloy is formed, which cannot be destroyed except as the mass of which it is a part is destroyed. The richness of the alloy is proportional to the depth of impregnation, which varies with the length of time of the treatment.

In a calorized steel tube, on the outer and inner surfaces of the tube a thin film of alumina is formed,

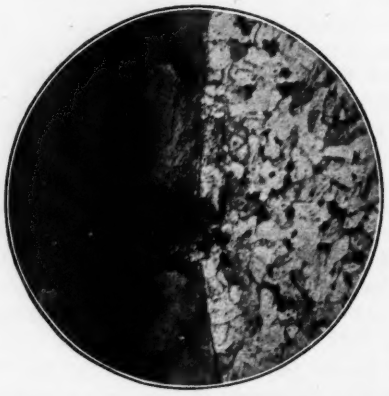


FIG. 3. INSIDE BEND OF FLATTENING TEST ON CALORIZED TUBE. NOTE HOMOGENEITY OF CALORIZED MASS (LIGHT PORTION)

and the thickness of the metal is increased by this slight amount. Under this a wide band of ferro-aluminum is found; in the center the steel remains unchanged.

Of the first questions arising in connection with the adoption of insuluminum to the Diamond Soot Blower system was its ability to withstand the stresses of hard service. The mechanical properties of the new material

had to be determined accurately. On this point the General Electric Co. stated: "The coating produced by calorizing is so hard that considerable effort is required to break through it with a file; consequently, such scratches or scrapings as it receives in normal handling need not be feared at all."

To supplement this information, the Diamond Power Specialty Co. conducted severe tests of insuluminum tubes, subjecting the metal to bending, flattening and hammering processes. The results proved conclusively the homogeneity of the mass, and its ability to withstand such severe treatment without failure, as seen in Figs. 1 to 3.

Insuluminum will resist for an indefinite time the continued action of temperatures of the order of 1000 deg. C., or 1800 F. This is an exact statement of the heat-resisting quality of the new metal. Its importance is apparent from the fact that steel begins to burn, at apparently about 700 deg. F. (370 deg. C.), and nickel at 1200 deg. F. (650 deg. C.). Both of these metals will bear considerably higher temperatures, of course, but the oxidation of iron and steel becomes pronounced at 930 deg. F. (500 deg. C.), and increases rapidly from this point on.

FIG. 4. "A," UNCALORIZED PIPE SPECIMEN, AND "B," SPECIMEN CUT FROM THE SAME PIPE AND CALORIZED, AFTER SEVERE HEATING AND PLUNGING TESTS

As evidence of the performance of calorized iron under test conditions, the pipes, both cut from the same piece, shown in Fig. 4, were photographed. The longer one only was calorized, and after treatment was alternately heated to 1830 deg. F. (1000 deg. C.), and cooled, in an electric furnace open to the air. The total time during which the maximum temperature was maintained was about 50 hr. Next it was heated to 1650 deg. F. (900 deg. C.), and plunged into cold water after it had cooled to a dull red. This was repeated 3 times, but the surface showed no signs of cracks nor any tendency to scale. Finally, this piece and the untreated one (A) were heated side by side with an ordinary blast laboratory lamp to a temperature of about 1650 deg. F. (900 deg. C.), for a period of 4 hr., then cooled and the heat once more applied for 4 hr. At the end of that time the untreated pipe was badly burned, the point where the flame was applied directly having been reduced to ½ the original thickness, while the whole surface was blistered. The contrast between this piece and that which was calorized (B) was very marked, for even upon close examination the latter appeared to be unchanged.

Figure 5 shows a similar comparison between 2 pieces of sheet iron tube, one calorized and the other not, both subjected to a temperature of 1470 deg. F. (800 deg. C.), in a gas furnace for 100 hr. The uncalorized piece is practically destroyed while the calorized piece is unharmed. The results of a sulphur dioxide and other tests were shown in the issue of Mar. 1.

Every material has an oxidation point, and that of insuluminum is around 2000 deg. F. (1100 deg. C.). If the alumina film is broken scaling will set in at a temperature above 1920 deg. F. (1050 deg. C.), but if the film is unbroken the scaling temperature will be higher.

The high heat-resisting quality of insuluminum makes it much less subject to warping than cast iron or steel, and the new metal will undoubtedly play an important

FIG. 5. CALORIZED AND UNCALORIZED SHEET IRON PIPE AFTER 100 HR. IN A GAS FURNACE AT 1470 DEG. F.

part in the industrial development of the future. So satisfactory has its use proved that a demand has been created among the manufacturers of boilers, superheaters, economizers, stokers, annealing ovens, condensers, etc., for permission to use the material in those parts of their products that are exposed to continuous high temperatures, and arrangements are now being made by the licensees whereby they may be supplied with the metal.

PLANS ARE under way to flood light the Statue of Liberty in New York harbor, on the eve of America's Electrical Week, as a country-wide recognition of this international bond of fellowship and of the importance of the electrical industry. The Statue of Liberty, which was presented to this country by the Republic of France, is the property of the entire country, and not of any one city or section. It belongs to the nation, and this flood lighting will most appropriately become part of the national electrical celebration starting Dec. 2, and will be marked by the presence of the Atlantic fleet and prominent civic and government officials. The funds for the flood lighting plant are being provided by popular subscription, the school children of the country contributing largely for this purpose; the subscribers to date number 71,000. It is not desired that large subscriptions be made, as the thought is to have this a representative American project, including the greatest possible number of citizens. The plans are in charge of J. M. Wakeman, general manager of the Society for Electrical Development, 29 W. 39th St., New York City.

A BUSINESS HOUSE in Venezuela desires to purchase an icemaking machine for its plant. Catalogs should be in Spanish, and further information can be had from the Bureau of Foreign and Domestic Commerce, Washington, D. C., referring to No. 22,607.

Refrigerating Experiences

BROKEN FITTINGS CAUSE GREAT ANNOYANCE AND EXPENSE. BY C. E. ANDERSON

THE first bad ammonia leak it was my misfortune to experience will always remain fresh in my mind, on account of its peculiar action on myself.

I was connected with a plant containing about 40 stands of double-pipe ammonia condensers. They were about the first of this type to be installed and gave considerable trouble from gaskets blowing out. These stands were set on about 12-in. centers, which did not give room enough to work around them properly.

One day a gasket blew out on a center connection, and on account of the close quarters and the rigid connections, it took me almost a day to make the repair. The stop valves on that particular stand leaked so much that a candle would not burn in the condenser room. By making frequent trips to the windows, I managed to get the job done. I did not notice any effects of the ammonia at the time; but the next day, and for quite a while afterward, my eyebrows were so tender and sore that I thought each hair was being burned around the roots. I have often related this experience to refrigerating engineers and no one ever offered a plausible explanation. Sometime after this experience, I was working in a plant that manufactured ice among other things. The natural ice crop was short that season, which created a great demand for artificial ice. The price was almost doubled and the plant capacity was forced up from 230 to 300 tons a day. Water for condensing the ammonia was scarce and the increased capacity put a very heavy load on the condensers. The condensing pressure varied from 240 to 270 lb. per square inch, due to the varying amounts of moisture in the air; for, on a muggy day, the cooling towers were not very efficient, hence warmer water for the condensers. To hold the condensing pressure as low as possible, the cooling water was pumped through the coils at such a rapid rate that the water was heated only 40 deg. When running at the ordinary rate, the condensing water left the condensers from 15 to 20 deg. warmer than the inlet temperature.

The jar of the water pumping and the vibrations from the compressors, in connection with the high condenser pressure, were enough to cause a good many return bends to burst that season. When one of these bends burst, it made a noise that was heard for blocks and crowds of the morbidly curious would gather in the street outside of the plant to see how many had been killed. The broken bends usually allowed nothing but hot gas to blow out into the room; but when the break was bad hot gas would come out through the upper part of the break, and liquid ammonia would back up out of the liquid header and splash out through the lower part of the break. We had a safety helmet and we became quite expert in shutting off the broken stands. The bends broke at nearly all the different heights on the stands, and formed a practical demonstration of Professor Siebel's theory that superheated ammonia gas gives up its heat very slowly.

There were 44 stands of double-pipe condensers, with a 1¼-in. pipe inside of a 2-in. pipe. The stands were 12 pipes high and 18 ft. long. When the top bends of a stand burst, we could hear the roar, but could not see the ammonia escaping because superheated ammonia gas is perfectly invisible. The only way to find the break was to run along in front of the stands until the blowing gas could be felt, when that particular stand was shut off.

The liquid or lower stop valve was always shut off first, because, if the top or gas valve was shut first, there would be a clear field for the liquid ammonia to splash out through the break, and then it required pure nerve to crawl through it and shut the stop valve. The escaping gas always came out transparent when any of the 8 top bends would break, but when the fourth pipe from the bottom was open, the escaping gas could just be noticed, as it was a little smoky, and the gas coming out through a break lower down would look like a blue mist.

From these breaks, it looked as if 12-pipe stands of condensers were not high enough, because it took the 8 pipes to take out the superheat and left only 4 pipes to take out the latent heat so that the ammonia gas could condense into a liquid. It is not consistent engineering to expect 4 pipes to take out twice as much heat as 8 pipes will; the proportion ought to be reversed. We blew away thousands of dollars worth of ammonia that summer and the foregoing were among the useful things we learned.

One day a bottom bend burst and the break opened in such a way that liquid ammonia was blown out on the bottom stop valve. To shut this valve, I was forced to crawl through about 10 ft. of blue gas, and while it took only a few seconds to close the valve, I experienced severe burning sensations. We had another break about 15 min. afterward, which also happened to be on a lower pipe, and I experienced the same physical effects. The other men who shut off any of these breaks always experienced the same sensations when going through an ammonia fog.

We read everywhere that ammonia gas is lighter than air and that the safest place is near the floor when ammonia is escaping. This statement needs to be qualified somewhat, as my experience has been that the ammonia gas will stay down close to the floor as long as it is visible, and it rises only when it becomes "superheated by contact with warm air."

I have known ammonia gas to settle close to the floor, in cold rooms, when it was perfectly safe to walk through the ammonia fog without a helmet in order to shut a valve.

U. S. CIVIL SERVICE COMMISSION announces an examination for clerk-draftsman, on Nov. 22 and 23, to fill vacancies as they may occur in local branches of the General Land Office Service at $1200 a year, and in positions requiring similar qualifications. The following subjects will have the relative weights indicated: Report writing (an orderly, concise, and grammatical statement, not more than 200 words in length, of the essential facts included in a given statement of 400 or 500 words), 10; arithmetic and elementary mathematics, 20; copying and correcting manuscript, 10; public land surveying, 20; drawing and lettering, 40. Age 18 yr. or over on the date of the examination.

Applicants must submit their photographs. Apply for Form 1312.

LETTERS DIRECT FROM THE PLANT

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Power House Troubles

THE NIGHT before Christmas in a power or lighting station is a busy time. I had just returned from supper to find every engine and machine loaded to the muzzle, and received word that on the principal lighting engine, a McIntosh & Seymour, the overhanging eccentric pin used in place of an eccentric was running warm and needed close attention to avoid a shut down which on this night would be equal to death to any engineer.

Cautioning the oiler to use cylinder oil if it smoked, I proceeded to look over the machines throughout the station. As I entered the pump room, I found one of the large condenser pumps had chewed the packing out of the valve stem stuffing-box, which allowed the rod to slip back, making the pump reverse on ¼ or ½ stroke; in other words, kick badly, sometimes stopping. The condensers were loaded to their full capacity too, and it

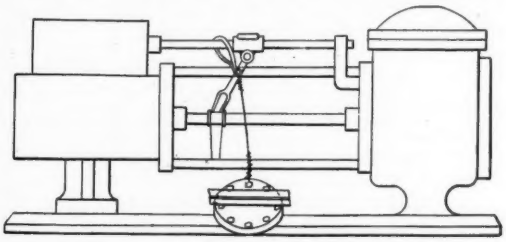


FIG. 1. WEIGHT ON PUMP VALVE ROD

was impossible to think of running without it, as no one of the engines would carry its load running high-pressure. Quick action was necessary. I had picked up a piece of belt lace off the desk on my way around. This was too short. Remembering I had placed a piece of iron wire outside the door, I secured it and connected it to the lace, which I had looped around the valve rod. I attached the wire to a large blank flange, bringing wire over the frame at one side. I left one edge of the flange suspended about 3 in. The other edge rested on the floor, this being done on account of not having room to suspend a heavy weight and steady it from the vibration. This was not weight enough so I piled more junk on the flange which cramped the valve rod in the stuffing-box and the guide and prevented it from slipping and the pump kicking or stopping, thus completing the run when the valve rod was repacked and a new rod put in as soon as received from the shop.

Returning to the engine room, I hastened at once to see what had happened to the eccentric pin on the McIntosh & Seymour engine. It was very much hotter than when I left it, and I at once sighted from the rocker arm past the wheel to see if the rod had become sprung to throw it out of line. To my surprise and horror, the governor wheel was coming off. It was a separate wheel set on the shaft beside the flywheel, and had moved about 1½ in., the eccentric rod cramped against the pins being the only obstruction in its way. How long the pins would stand this strain, I could not tell. The rocker arm pin was also getting hot. Something had to be done at once; but what? Looking back of the engine among a pile of blocking, I picked up 2 pieces of ⅞-in. boards about 18 in. long, telling the oiler to hold one against the rim of the wheel on one side while I held the other against the rim on the other side, hoping, as it seemed against hope, that our combined pressure might force it back on the shaft somewhat. Both at once could not move it. The oiler immediately let loose on his side, leaving me pressing on my edge alone. Immediately the wheel seemed to cant toward the engine on

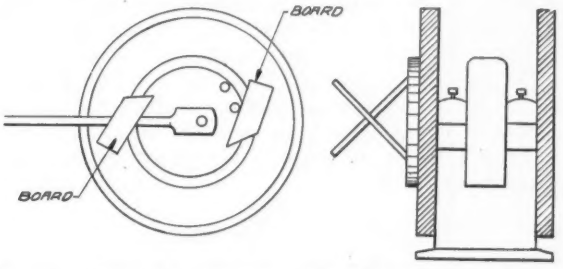


FIG. 2. METHOD OF PUSHING GOVERNOR WHEEL ON SHAFT

the edge on which I was pressing. As I looked toward the oiler, he pressed against the rim again. I noticed the wheel seemed to cant again on that side. As he shouted to me to this effect, we continued to press the boards against the rim alternately and in a very few times the wheel went back into its original position. After making a few more rounds, both pins had become very cool; so we repeated the operation once more during the evening, completing the run without a stop or accident.

The next day, examination showed that one of two set screws which pressed on the key in the governor wheel had become loose and the other being outside of the center line, had a tendency to make the wheel wabble which made it crawl off toward the end of the shaft; hence, it was only natural that it wabbled back so easily when we pressed against it with the boards.

It is not many places we find a machine with brass babbited boxes in 6 pieces, all fitted to the shaft and standard which support them. This was a General Electric machine which had been purchased second-hand. The machine had been started for the evening load and every machine was loaded heavily. I was informed by the oiler that the bearing next the pulley was running much

hotter than usual. This was hard to tell, as it had always run so hot it could scarcely be touched without burning the hand. But when I reached the machine it was smoking and not a machine in the station to carry the load, and not an engine that would take any part of the load in addition to what it had. This engine just had to be kept running. How to do it was a puzzle, as the box had already been filled with cylinder oil, which should have cooled it, but had little effect. Grabbing the hose from the hook, I bade the oiler hold it over the bearing while I started the air pump.

Returning to the machine, I wired the hose to the guard rail over the pulley, the nozzle being just high enough over the box to allow the air to strike it the whole length. The effect was much more than I expected, for it stopped smoking in a very few minutes and one could place the hand on the bearing without burning; but on lifting the covers over the oil ring, I found the oil to be boiling continuously throughout the run. I expected to have to replace the boxes with a duplicate set, but when I removed the brasses, I was surprised to find the prettiest set of brasses I had ever seen as they were ground to a perfect fit to the shaft. I simply filed the burs off the edges and replaced them and could not wish for a better running bearing. But sorry to say, due to a change in watch engineers and oilers, the box was neglected and a week later, the engineer, not knowing of the air hose cure, melted the babbit entirely out and had to stop the machine, putting out the lights.

The air hose has been used many times since.

This box was too small to give sufficient bearing surface for the load, weight of belt and speed. Being in 6 pieces, it was impossible to bore them true and have the flanges fit the standard. Scraping was the only method of any avail. R. A. CULTRA.

Care of Leather Belts

I WAS MUCH INTERESTED in the experiment which N. G. Near explained in the Oct. 1 issue, in which was stated that the smooth side of a belt should run next to the pulley. I would like to offer an answer to the same problem.

It is well known that by running the hair side next to the pulley there is considerable gain in driving power when the belt is new. If a belt is given a coat of good dressing and boiled linseed oil, say 3 times a year, the flesh side will soon become as smooth as the hair side, and the driving power will be fully as good, because this oil oxidizes and the surface becomes gummy, thus giving the belt a smooth, elastic, driving face, in which there will be no more air pockets than in the hair side. The natural curve of a belt is inward, thus when the belt is run over a pulley this closes the air pockets upon themselves and if well lubricated, as before mentioned, the flesh side is as good for driving purposes as the hair side; it will also run well and the wear and tear will be inconsiderable.

A belt working with the flesh side next the pulley really has a much longer life than a belt running with the hair side under the same conditions. The reason is that one is working with the natural growth of the hide, while the other is working against it, to prove this, take a strip of belt leather, pull it well and lay it down; you will at once notice that the leather naturally curves flesh side inward. When you try to bend it the other way it is quite hard. Therefore, nature teaches us what practice proves to be correct, to run the flesh side next the pulley.

After having been taken up once or twice during the first year, good belts require very little attention, except for being kept clean and lubricated, during the rest of their long life. Of course, if belts are not well looked after or lubricated, there will be slippage, but if they are attended to as before mentioned, the life will be much longer, the driving power just as good, and slippage will be almost unknown, if run with the flesh side next the pulley. WILLIAM THOS. ESTLICK.

Careless Operation

FIGURE 1 illustrates a group of power transmission apparatus as installed in a plant running day and night. In the cut, 1 is a waterwheel, 2 a high-speed condensing engine, 3 and 4 are jaw clutches by which means the load driven from 5 can be carried by water, steam or both at will.

One winter morning, anchor ice so clogged the racks that sufficient water could not get into the wheel and maintain the usual speed. As the lights for the entire plant were driven as part of the load from 5, the lights grew dim and the operator hastened over to start up the engine, 2, and this is the way he did it.

By the aid of an oil lantern, he opened wide the drain valve above the throttle, then closed it, shut down the waterwheel, put in the jaw clutch, 3, cracked the

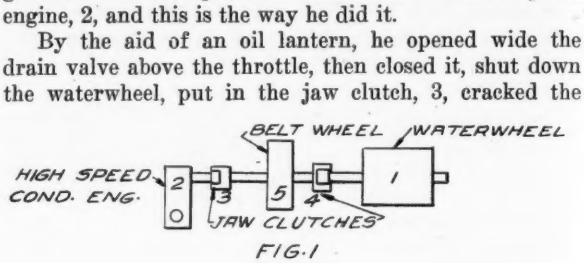


FIG. 1

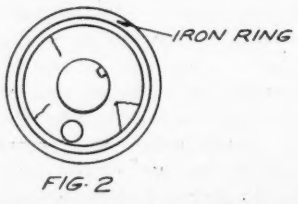


FIG. 2

FIG. 1. ARRANGEMENT OF TRANSMISSION APPARATUS
FIG. 2. CRACKED CRANK DISK AS REPAIRED

throttle on 2, and started the wheel, 1, at a lively clip. Result, the pipe line emptied into the cylinder and the crank disk, Fig. 2, was cracked as shown, the cylinder head broken.

The crank shaft was taken out of the bearings, sent to the blacksmith shop, where a heavy iron band was welded up and shrunk on the disk, then faced up on the lathe.

After having this experience, the operator made it a practice to put the crank on the dead center and open the throttle for a few minutes, then close the throttle and turn the crank to the other center and repeat.

The proper way was to have a reliable steam trap connected to the drip above the throttle to keep the line clear of condensation at all times. Then by carefully handling the rocker arm and opening the throttle, the engine cylinder may be warmed. The practice of mov-

ing an engine a part of a revolution in one direction and then in the other is not commendable, not only due to chance of damage to goods in the plant, but often belts are run off the pulleys and not infrequently the keys securing the pulleys to the shaft are loosened.

In cases where an engine operates in conjunction with wheels, the engine should be started first and in stopping the wheel should have the gate closed before the engine throttle is shut. Frequently, poor results in speed regulation are traceable to having both engine and wheel governors in operation at the same time.

Usually the engine governor is more sensitive than the other, and trouble results. The desirable thing in most cases is to run the gate on the wheel at a fixed opening, let the engine carry the balance and do the regulating.

In the operation of wheels, care should be given to the stuffing-boxes where the shaft enters the wheel casing to keep them tight, and they can often be water-sealed with advantage, for a slight leak here will destroy the vacuum in the draft tube and so result in a reduction of effective head. RECEIVER.

Removing a Pulley

THE METHOD described in the article in the July 15 issue, on removing a tight pulley will do the job, but I use a scheme I consider better. I have pulled the rim of a pulley right off the hub, spokes and all, this way. With these hooks on the outside of the rim, the strain of pulling comes on the rim, and only in 2 places. I use a jack and 2 bolts in place of Mr. Brough's hooks; but I put the bolts under the rim and between 2 spokes, and put a plate on each bolt across the back of the pulley

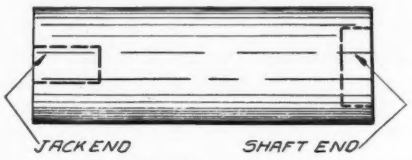


FIG. 1

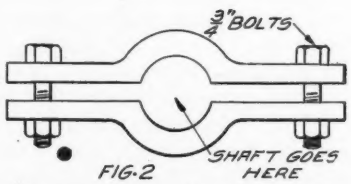


FIG. 2

FIG. 1. IRON FITTED BETWEEN JACK AND END OF SHAFT
FIG. 2. CLAMP USED WHEN REMOVING PULLEYS

where he has the hooks. This gives me an even strain at 4 points on the rim in place of his two. I use no wood in the job. The straps or plates that I use behind the pulley are iron, 1 by 3 in. or 1 by 2 or 1½ in. square. The one I have behind the jack is 1 by 4 or 1½ by 3. I use just as short bolts as I can, size ¾, ⅞ or 1 in.

To keep my jack from kicking out, I take the top off and put a piece of shaft on in place of it. The piece is 4 in. long with a hole in one end just deep and large enough to fit where the top of the jack was taken off. The other end has a hole that will just go over the end of the shaft. When I get the pulley out to the end of the shaft, I take another piece of shaft 4 in. long with a hole in 1 end to go on the jack, but this piece is small enough so that the pulley will come off over it. This is nothing new, I have been using it for 20 yr. and I have been taking Practical Engineer all these years too.

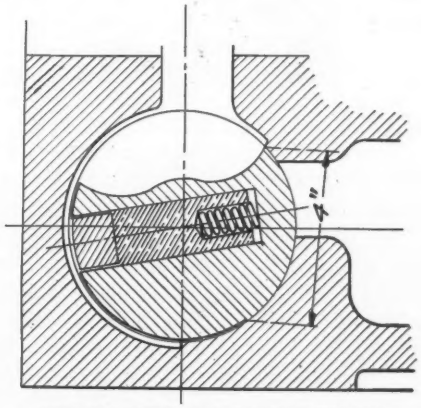
I have still another method that I use when I can't start the pulley by pulling on the rim. I have a device with which I can pull on the rim and hub at the same time and have a bearing all around the hub and at 4 points on the rim. It consists of 2 straps made of ¾ by 3 in. iron shaped as in Fig. 2. This double strap goes over the shaft, behind the pulley with the pulling bolts stuck through it. If the hub and rim are not the same width then I build up with iron blocks or split collars to get the strain on hub and rim at the same time.

With this last method I have never broken a pulley nor seen one broken, but I have seen them broken several times by pulling on the rim. E. D. MAYNARD.

Twisted Valve Stems

IN A LATE issue, one of the subscribers told of certain trouble he had on account of the twisting of a valve stem on a Corliss engine.

In 1894, I installed a pair of 20 by 36-in. link motion engines with Corliss valves, to operate a passenger inclined plane railway; the engines, on the average, run 1 min. out of every 6, so that there is a period in which condensation can take place in the cylinder. During the first few days that these engines were in operation, the exhaust valve stems twisted to such an extent that it was hard to complete the trip, first on one engine and then on the other, showing that there was an excessive strain, probably due to the condensed steam washing the lubrication off the valve seat and to an excessive



SECTION THROUGH CORLISS VALVES

pressure on the valve when it was called upon to open.

In a pair of reversing engines, it is necessary to have a late cutoff with a resultant high terminal pressure at the time the exhaust valves start to open. In these reversing engines, although the point of cutoff was about ¾ stroke, there was a certain amount of wiredrawing through the throttle and the terminal pressure was nearly 40 lb.

The accompanying drawing shows a cross section of the exhaust valve and it will be seen that in the closed position the contact surface between the seat is about 4 in. wide and as the valve was over 25 in. long, the un-

balanced surface amounted to fully 100 sq. in., with 40 lb. pressure per square inch, or a total of 4000 lb. holding the valve to its seat; this, we decided, caused the trouble.

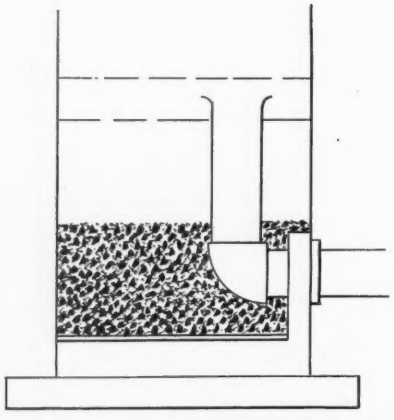
The phosphor bronze valve stems were replaced by steel stems which have been in service up to the present time, fully 22 yr., and have given no trouble.

B. L. B.

Clogged Filters

MR. HAWKINS' letter on page 842 of the Oct. 1 issue, having reference to a clogged suction hood, brings to mind a somewhat similar experience which we had sometime ago, the clogging up and choking of the filter placed in the bottom of the heater. We did not desire to dispense with the filter because it retained considerable mud and suspended matter, yet the frequent clogging up of the filter, preventing sufficient water from reaching the pump, was undesirable.

We overcame this trouble and secured a positive flow of water at all times by installing a bypass pipe from above the filter bed directly connecting into the pump suction hood at the pump supply opening, as shown in the sketch.



METHOD OF BYPASSING AROUND FILTER IN A HEATER

When the heater was running at capacity, the water level was carried about 2 in. below the line at which the flow valve closed off completely. We brought the upper edge of the bypass pipe, which was flared, just above this line so that when the water began to back up when the filter clogged, and before the regulating valve would close, the water would flow into the bypass pipe direct to the pump supply opening. In other words, the water would flow through the filter until it was clogged to such an extent that it would not pass the required amount of water, when the bypass pipe came into action and supplied the deficiency, thus insuring water to the pump at all times.

M. A. SALLER.

Induced Draft for Small Boiler

FIGURE 1 shows how I use a steam ejector to induce draft in a small boiler that was used to run a steam pump when washing and filling the larger boiler, and also to furnish steam for office in winter time. The draft was not previously sufficient to keep up steam. I also made a flue blower as shown in Fig. 2, and there was no more trouble about keeping up steam. In making the flue cleaner I put in a ½-in. T and screwed in a bolt, as at A, and painted it the same color as the blower. One can then use it as a handle.

Figure 3 shows how we pack the manhole plates. Clean the plate and then put on a good capping of pine tar and then twist ½-in. asbestos wicking and put 4 rings or turns of it around the plate—there is no need

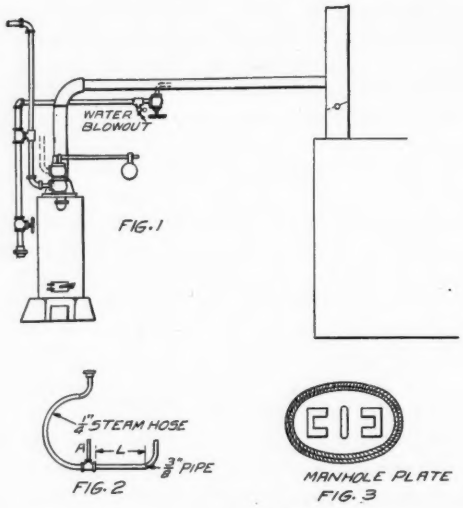


FIG. 1. HEATING BOILER WITH INDUCED DRAFT APPLIANCE
FIG. 2. FLUE BLOWER FOR SMALL VERTICAL BOILER
FIG. 3. ASBESTOS GASKET FOR MANHOLE PLATES

of breaking the joints. Then take a small hammer and hammer it lightly all around, and put a coating of graphite and oil on the top of it. We have used this kind here for many years, and it seems to give good results and will last a long time if taken care of.

A. L. JOHNSON.

MUCH PUBLIC INTEREST has recently been attracted to the Caterpillar tractor owing to the use to which it has been put in the European war. This form of tractor was developed by Benjamin Holt to meet the reclaimed land conditions of California and has long been put to use in the agricultural industry of the west. The drive wheels are endless chains properly filled in with shoes to prevent sinking and slipping; between front and rear chain wheels are flanged truck wheels that run over the track formed by the chain. This construction enables the tractor to travel over the softest soils and sandy places as well as cross ditches, fallen trees, etc., and the independent track drive makes turning in its own length possible. The use to which these tractors have been put abroad is another example of how implements used in peaceful industries may be easily converted into means for the defense of a nation at war.

THE SOCIETY for Electrical Development is providing for those interested in pushing America's Electrical Week, Dec. 2 to 9, poster stamps, window cards, pennants, bill posters and movie slides, all of which are furnished free to members of the Society, and to others at nominal cost. Full descriptive circulars and price list may be had from the office of the Society, 29 W. 39th St., New York City.

Questions Answered and For Answer

Expert Help When In Trouble. If You Want Quick Answer Enclose a Stamp

Babbiting Crosshead and Crankpin Boxes

KINDLY DESCRIBE the proper method of babbiting crosshead and crankpin boxes. Also, what grade of babbit would you employ for this work?

I have tried graphite bearing metal, but have found that this will not adhere to the brasses, so am doubtful whether it is any good for such work. H. W. S.

A. The matter of babbiting boxes on engines is one that must be governed by local conditions more or less and what I have to offer in instructions must be in a general way only.

After all is said and done, the best thing to use in babbiting any kind of engine box is genuine babbit of the best grade. There are about 600 kinds of babbit, or rather anti-friction metal, on the market, each one of which has its particular use in meeting certain conditions, but for crank and crosshead pin boxes, an "A" grade genuine babbit will give you as good service as anything you can obtain.

Babbit containing a graphite mixture seems to be difficult to handle, as it requires a certain amount of skill attained only by experience, and most engineers do not have enough babbiting to do to become proficient in handling the molten metal in the best manner.

Any grade of the best babbit is easily handled, the only restriction being that the workman must be careful not to burn it. There are several kinds of so-called "red metal" that are excellent, but these, too, require some experience in handling in order to secure the best results. Some of these metals are cast by the manufacturers in any desired form and can be machined to suit the bearing.

It is seldom, however, that local users are able to make a red metal that is satisfactory, or to re-use purchased metal and have it work well. So, all in all, genuine babbit of the best grade, and known to be as represented, fills all conditions, on the whole, better than anything else.

As connecting rod boxes are usually of brass construction, they can be tinned previously to re-babbiting by heating in a clean fire and while hot, using a flux of sal ammoniac with ordinary solder, so that the interior of the box is well coated with a thin coat of solder to which the babbit will adhere by fusion as soon as poured.

If it is not possible to tin the brasses, then see that they are properly fitted with anchor holes, at least ⅜ in. in diameter for the smaller boxes, up to ⅝ in. for the larger ones, and proportionately deep. After these holes are drilled as required, use a smaller drill and drill 2 or 3 holes at an angle in the bottom of the anchor holes, which will prevent the anchor from working loose with service. Another good idea is to countersink the anchor holes at an angle of about 45 deg., just enough to break the edges. This prevents the anchors from breaking off at the edge of the hole, as would otherwise be the case in many instances.

As how to go about the job of babbiting, that depends much on the job and what you have to do it with. It is seldom that a crankpin box can be babbited on the pin on account of local difficulties, such as the pin being out of round, or scored, or the location may be such that it is inaccessible with a ladle full of hot babbit, and also on account of the difficulty in heating the pin to insure a good pour.

With the crosshead pin, it is absolutely impossible to babbit it in place so it is obviously best to babbit the boxes on a mandrel, and preferably a smaller one than the pin, and then bore the box. To prepare a box for the operation, first knock out the old babbit or melt it out and make whatever changes in the anchor holes are necessary.

If convenient, make your mandrel of cast iron, of such shape that when ready for use it will resemble a part of the crank disc with the crankpin in place. A pattern for such a casting can be made by any engineer in half an hour, and the casting with the necessary machine work will cost but a small amount even if made at an outside shop. If you wish to babbit the box without boring, make the mandrel the same size as the pin, and after relieving the box about an inch or so back from the joint, the bearing can be quickly made with a scraper.

If you wish to bore the box have the mandrel from ¼ to ½ in. smaller than the pin and after pouring, peen the babbit well with a ball peen hammer and then bore to size. Having determined the way you intend to finish the job place the boxes in the rod, using the wedge to draw the box up to the shims which you place between the halves of the box for clearance and which should be not less than ⅛ in. and from that to 5/16 in., depending on the size of the box. Place the mandrels in a level position and as far apart, center to center, as the construction of the engine requires; having heated the mandrels to insure a good pour, place the connecting rod over the 2 mandrels.

It might be well to mention another thing; if for any reason it is necessary to have the babbit project beyond the brasses, provide a ring of suitable size and thickness for the brasses to rest on. A similar ring can also be placed on top of the brasses for the same purpose.

While all this is being prepared, have the babbit melting on a forge as near to the job as possible, taking care that it does not burn. Have enough melted to do the entire job at one pour, or at least one box or bearing. Have ladles enough, and of a size to suit the job and if

the job is a large one have at least 2 pouring at a time, and "one a-coming." This insures a good job without cold shots.

When the babbit will burn a pine stick, it is hot enough for the ordinary job; but if distance and temperature enter into the problem, the heat should be enough to fire a stick promptly.

Heat both the mandrel and the box, which not only eliminates the grease and moisture problem, but insures a good pour free from so-called "wrinkles." After pouring, scrape to a fit, or bore as required, taking care to relieve the boxes at the edge and to cut good oil grooves.

If not convenient to hold the boxes in connecting rod while babbiting, use a clamp made of strap iron of the proper size, taking care that the 2 halves of the box are in exactly the same position as when in the rod itself. Much more might be said along this line, but we believe that the above will cover the case you have before you.

G. H. WALLACE.

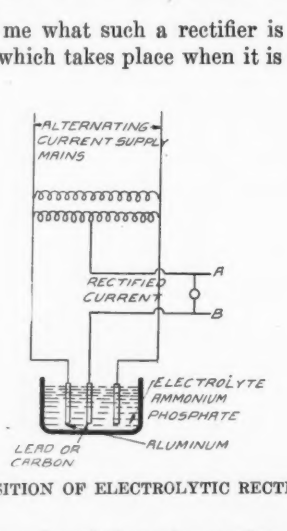
Operation of Electrolytic Rectifiers

IN THE institution where I am employed, we have a chemical rectifier used for charging a small storage battery from an alternating-current circuit.

The rectifier is made up of an earthen jar 12 in. in diameter and 14 in. deep with a wooden top supporting 2 1¼-in. rods extending into the contained solution. One of these rods appears to be carbon, while the other looks like aluminum.

Kindly tell me what such a rectifier is composed of and the action which takes place when it is in operation.

F. S. W.



COMPOSITION OF ELECTROLYTIC RECTIFIER

A. It has been found that when a plate of aluminum and a plate of lead or carbon are immersed in certain solutions, an electric current can be made to pass in one direction, but not in the opposite direction. In other words, this combination will act as an electric valve, and is the basis upon which the electrolytic rectifier and electrolytic lightning arrester are designed. The more complex the acid radical employed in the solution of the electrolyte, the more complete will be the valve action with a given voltage, or, in other words, the higher will be the voltage which may be satisfactorily rectified. In view of these facts, recent developments have been made in the use of ammonium phosphate or sodium borate dissolved in water, as the basis of the electrolyte.

The electrolytic rectifier, therefore, consists essentially of 2 aluminum plates and one lead or carbon plate immersed in a solution of ammonium phosphate and connected as shown below. Such an arrangement will allow the current to pass from the lead or carbon plate, but never from the aluminum plates, with the result that the current flowing between the terminals marked A and B will be unidirectional, but pulsating.

Such a rectifier is comparatively cheap, simple to construct, requires no sustaining circuits, and to this extent, is satisfactory for handling small loads where the service is intermittent. Its efficiency is comparatively low, seldom exceeding 60 per cent. Its present field of utility appears to be limited to X-ray equipments and experimental purposes. O. H. H.

Electrical Horsepower Calculations

WE HAVE a 600-v., 144-amp., alternating-current generator; the switchboard instruments consist of one voltmeter, one ammeter and a polyphase wattmeter. How can we calculate the horsepower by the use of these instruments? The power factor of the generator is unity. M. W. C.

A. The horsepower of your generator will be the watts divided by 746.

You speak of having a polyphase wattmeter; we presume this is a watt-hour meter, recording the watt-hours delivered. In such a case, you would have to take 2 readings of this meter at, say, 30 min. apart, multiply the difference of readings by 2 to get the watts, and divide by 746.

While the power factor of the generator may be one, the horsepower delivered, or the wattage delivered, will depend on the power factor of the entire circuit. If you could be sure that the power factor is one on the circuit, then you can multiply the volts by the amperes and divide by 746 to get the horsepower.

Be sure that your wattmeter reading is in watt-hours rather than kilowatt-hours. If it is in kilowatt-hours, you must multiply the reading by 1000 to get the watt-hours, then divide by the hours over which the reading is taken. A. L. R.

Air Space Required in Grates

WE ARE USING grates having a ¼-in. air space under 225-hp. Heine boilers. The stack is 56 in. in diameter and 80 ft. high. Would there be any saving of coal by using grates with a larger air spacing? L. L. M.

A. The width of the air space in the grate depends almost entirely upon the size and kind of coal used, but it is doubtful in this case whether increasing the air space would effect a saving in coal. As a rule, the total area of the air space is made from 30 to 50 per cent of the total area of the grate.

An instance is recorded of grate bars with an opening of only ⅛ in., and the total air space only about 15 per cent of the grate surface. In a test with Pittsburgh mine run and a draft of 0.46 in. over the fire, the rate of combustion was 24.8 lb. of coal per square foot of grate surface per hour, a rate sufficient to drive the boiler to much above its rated capacity.

Another case is on record of a test made with Illinois coal containing a large amount of sulphur. With air

space ½ in. in width and draft of 0.4 in., it was impossible to obtain a rate of combustion sufficient to develop the rated capacity because the coal fused into glass-like clinker which ran into and choked the air spaces.

A table in H. deB. Parson's book on steam boilers states that with a chimney 80 ft. in height above the grate, a rate of combustion of about 18 lb. of coal per square foot of grate surface per hour should be obtained.

If there is no decided tendency for your ash to clinker, and a sufficient draft is secured to develop the boiler's rated horsepower, it would be unwise to make any change in the grate, other conditions being normal.

Effect of Corliss Valve Lead

WHAT DIFFERENCE in effect has lead on the valves of a Corliss engine as compared with a plain slide-valve engine? F. C.

A. The effects of lead on the steam valves of a single-eccentric Corliss engine are no different from those obtained with a plain slide valve.

It may be well to note that in general the action of lead is threefold. On the steam end; first, it admits steam to the piston before the end of the stroke, and this steam acts as a cushion, enabling the piston to reverse its motion easily; second, it assists the admission of steam, tending to permit the steam passage to become supplied with steam at full steam-chest pressure by the time the piston reverses its motion. On the exhaust end; it assists to lower the exhaust pressure early in the return stroke.

With the double-eccentric Corliss engine, this third feature is not related to steam lead as the exhaust eccentric controls exhaust valve operation. W. P.

Hydraulic Press Calculations

How IS the power exerted in pressing or forming the plates in a 4-column flanging press figured? We have a pressure of 1200 lb. gage at the pump, a good sized accumulator and a good boiler pressure.

In this press the lower platen rises, although in some instances the lower platen is stationary and the upper platen lowers. What are the relative advantages of such arrangements?

Could you assume an example? B. E. D.

A. Your question does not state the make of the hydraulic press referred to, nor do you make mention of any of the details of construction. We, therefore, will be compelled to consider it a simple hydraulic press of the 4-column type, provided with a single piston and simplex hydraulic pump.

The mechanical advantage of such a press is due entirely to the difference in sectional area of the pump and press plungers, and with assumed dimensions we will attempt to explain its principle of operation.

Let us say that the pump plunger has a sectional area of one unit, so that with the pressure stated, the total pressure exerted by this plunger is 1200 lb. Let us further assume the press plunger to have a sectional area of 10 units, each unit being subjected to 1200 lb. The total pressure acting on this press plunger and communicated to the piece of work is, therefore, equal to 10 times 1200 or 12,000 lb. This divided by 2000 will give a tonnage of 6.

It must, however, be remembered that in any such press, that which is gained in pressure is lost in distance traveled by the press plunger. In the case just assumed, we have a mechanical advantage of 10, and as a result, the pump plunger must travel a distance of 10 ft. for 1 ft. of travel of the press plunger.

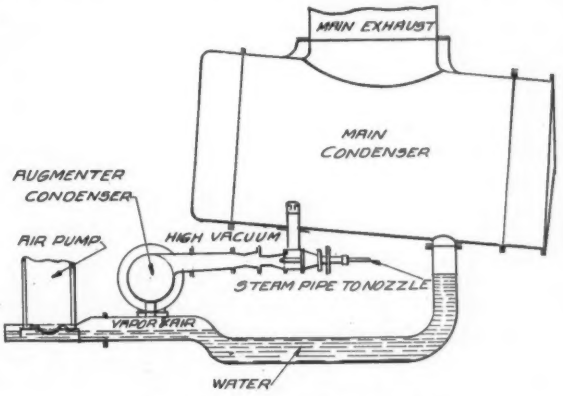
Just what the advantages are which may be gained by the use of movable upper and lower platens we do not know, but presume that one is made movable which will facilitate the work to be performed. O. H. H.

The Vacuum Augmenter

WHAT IS the purpose and the principle of operation of the vacuum augmenter? Under what conditions is its use desirable and where is it ordinarily placed?

ENGINEER.

A. The purpose of a vacuum augmenter is to assist in increasing the vacuum in a surface condenser. The accompanying sketch shows the location of a Parsons vacuum augmenter. Its operating principle is this: A pipe is led from the bottom of the main condenser to



PARSONS VACUUM AUGMENTER

an auxiliary or augmenter having about 1/20 of the cooling surface of the main condenser. At the point indicated, a small steam jet is provided which acts as an ejector and draws out the air and vapor from the condenser and delivers it to the air pump. The water seal prevents the air and vapor from returning to the condenser. Its use may be justified wherever a high vacuum is desired with a surface condenser. A dry vacuum pump is not correctly termed a vacuum augmenter.

Plenty of Good Smoke

A NEW ARRIVAL from the old country was appointed smoke inspector through the influence of his political cousin. Turned loose to inspect without any instructions, here is the report he gave in at the end of the first month:

"This is to certify that I have inspected the smoke of this city for thirty days past. I find plenty of smoke and apparently of good quality. Respectfully submitted."

PRACTICAL
ENGINEER

Trade-mark, Reg. U. S. Pat. Off.

PUBLISHED THE FIRST AND FIFTEENTH OF EACH MONTH
BY THE TECHNICAL PUBLISHING CO.
537 South Dearborn Street,
CHICAGO, ILL.

New York Office, 150 Nassau St.

Notify us at once of any change of address, giving the old and the new address, so that your paper may always reach you promptly.

Copyright, 1916, by Technical Publishing Co.
Entered as second class matter May 1, 1908, at the Post Office at Chicago, Illinois, under the act of March 3, 1879.

Circulation of this issue, 22,500.

CONTENTS.

Aurora, Elgin & Chicago R. R. Power Station. Illustrated 907
The Two Great Principles of Successful Buying. By H. B. Twyford. Illustrated....912
Indicators—I. Illustrated 915
American Association of Engineers Meeting....918
The Vibrating Rectifier Defined. By J. C. Grindell. Illustrated 919
Underground Distribution Systems. By G. J. Newton. Illustrated 921
Insuluminum. By Robert June. Illustrated....924
Refrigerating Experiences. By C. E. Anderson....926
Letters Direct from the Plant: Power House Troubles. Care of Leather Belts. Careless Operation. Removing a Pulley. Twisted Valve Stems. Clogged Filters. Induced Draft for Small Boiler. Illustrated....927
Questions Answered and for Answer: Babbiting Crosshead and Crankpin Boxes. Operation of Electrolytic Rectifiers. Electrical Horsepower Calculations. Air Space Required in Grates. Effect of Corliss Valve Lead. Hydraulic Press Calculations. The Vacuum Augmenter. Illustrated 931
Editorial: Saving Time. Editorial Comments. 934
A New Recording Thermometer. Illustrated....936
Durable Boiler Tube Cleaner. Illustrated....936
A High-Capacity Circuit-Breaker. Illustrated....937
Single-Pole Lightning Arrester for Transformer Protection. Illustrated 937
News Notes 937
Catalog Notes 939

Saving Time

While it is true that operation of a power plant resembles military engineering in that keeping in operation is of more consequence than expense, yet the reducing of labor and fuel costs in routine work is a part of the operation that tends to boost the plant manager's salary. And often the right supplying of power when and where needed becomes a direct means of large savings in the cost of operating the factory.

A case in point was a battery of four machines mentioned in The Power User, where the drive from a single motor was not heavy enough to carry all four at once. The operators therefore watched chances and took turns, to avoid throwing off of the belt from overload. While there was a slight saving in power, it was at the expense of keeping operatives idle a considerable part of the time, and a change in belt, with some rearrangement of pulleys resulted in largely increased production.

In other instances it has been found that motors much too large have been installed and, running at low load have given poor efficiency. In starting and stopping, time is often lost by inconvenient arrangement of valves, control levers and switches. Bad arrangement of coal supply makes hard work firing. Planning beforehand and getting tools and materials ready saves hours in an overhauling job.

As in every line of effort, the man who makes his brain save his muscles is efficient, and if he also makes it save the time and muscles of others he becomes doubly valuable. Time is the only thing that cannot be replaced. An effective minute has served its purpose well. A wasted minute has been of no service to anybody.

Editorial Comments

Slowly, even reluctantly, but surely, men controlling power plants are coming to the conclusion that their greatest opportunity for economy is in the boiler room. It has been customary for our best firemen to be advanced into the engine room. A good fireman may never make a good engineer, and vice versa; but a good fireman can be made a better fireman, a boiler room foreman or possibly an expert combustion engineer with proper encouragement, and his opportunities for saving the company's money are 10 to 1 in favor of the boiler room. What has been done in the way of economy at the plant of the Aurora, Elgin & Chicago R. R., as described in this issue, could be done in, we dare say, 90 per cent of the power plants of the country. Efficient operation of boiler rooms is the greatest need of the steam power plant today. Practical Engineer has been emphasizing this fact for years and proposes to keep its readers posted upon every new device, instrument, machine or system that will aid in this direction.

Many engineers of power plants purchase their supplies direct from factory or jobber without the necessity of putting the order through a purchasing department. To do this work most efficiently, considerable thought and checking up on the house purchased from, as well as clear, concise and accurate methods of ordering are required. Mr. Twyford gives some excellent ideas on the subject in this issue.

No one instrument has done more for the advancement of efficiency of the steam engine than the steam

engine pressure indicator. The instruments themselves have improved greatly in accuracy along with the development of the engine, and to use them intelligently an engineer must be familiar with the details of construction and causes of errors which may result in incorrect conclusions in regard to the operation of the engine. In this issue appears the first of 2 articles upon this subject, which have been written to aid readers to keep in touch with recent improvements in this instrument.

Among several successful mechanical devices for rectifying alternating current, the vibrating rectifier is probably the most simple and easiest to operate. Although it gives a pulsating current, which limits its use to certain fields, it is admirably adapted for charging of batteries, as explained by Mr. Grindell.

Underground systems of distribution offer many advantages over pole line systems, but they are more expensive, more difficult to repair and changes are doubly expensive. In a paper read before the Iron & Steel Electrical Engineers' Convention, G. J. Newton makes suggestions for designing a successful system, and the paper is abstracted for our readers.

Metallurgy claims another victory over the elements of Nature. This time, by producing, without sacrificing strength, a metal that resists the destructive effects due to high temperatures. Insuluminum, the new metal, is not prohibitive in cost to the power plant.

Accidents are frequently the source from which we get valuable information regarding design and operation of machinery. In his narration of experiences with ammonia leaks, Mr. Anderson criticizes the design of the condenser coils. Purely by accident he discovered that in a 12-pipe coil, 8 pipes are filled with gas, leaving only 4 pipes to do the greater share of the work. This division of the work seems wrong and invites investigation.

Actual, practical conditions, not always as we would have them, not always of our own making, but always real and following definite laws, are the things we meet in the power plant. We must face them squarely and become masters or pass on as failures. Read the "Letters Direct from the Plant" and these facts will be forced home to you in an impressive manner.

If you have not received it by mail, you will find the answer to your recent question in this issue. O, you did not ask any? Well, the question you should have asked may be answered here, or possibly, even probably, is not. That's your loss, and it's your fault. Others take advantage of their opportunities and receive a direct benefit. Read the answers to their questions and get an indirect benefit.

Has your interest been aroused in efficient operation of boiler rooms? Yes or no, you should read the descriptions of new power plant apparatus in this issue if you are at all interested in the plant.

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC.

required by the Act of Congress of August 24, 1912, of Practical Engineer, published Semi-Monthly at Chicago, Ill., for October 1, 1916.

State of Illinois } ss.
County of Cook }

Before me, a Notary Public in and for the State and county aforesaid, personally appeared Chas. Sanford Clarke, who having been duly sworn according to law, deposes and says that he is the Secretary of the Practical Engineer, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily paper, the circulation), etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 443, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are:

Name of— Post-Office Address—
Publisher, Technical Publishing Co., 537 S. Dearborn St.
Editor, Arthur L. Rice, 537 S. Dearborn St.
Managing Editor, Arthur L. Rice, 537 S. Dearborn St.
Business Manager, E. R. Shaw, 537 S. Dearborn St.

2. That the owners are: (Give names and addresses of individual owners, or, if a corporation, give its name and the names and addresses of stockholders owning or holding 1 per cent or more of the total amount of stock.)
E. R. Shaw, 537 S. Dearborn St.
Arthur L. Rice, 537 S. Dearborn St.
Chas. S. Clarke, 537 S. Dearborn St.
C. B. Leech, 1472 W. Clifton Blvd., Cleveland, Ohio.

3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are: (If there are none, so state.)

There are none.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company, but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other persons, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

5. That the average number of copies of each issue of this publication sold or distributed, through the mails or otherwise, to paid subscribers during the six months preceding the date shown above is: (This information is required from daily publications only.)

Chas. Sanford Clarke, Sec'y.

Sworn to and subscribed before me this 30th day of September, 1916.

Warren A. Lathrop, Notary Public.
[SEAL] (My commission expires October, 1918.)

NOTE.—This statement must be made in duplicate and both copies delivered by the publisher to the postmaster, who shall send one copy to the Third Assistant Postmaster General (Division of Classification), Washington, D. C., and retain the other in the files of the post office. The publisher must publish a copy of this statement in the second issue printed next after its filing.

Power Apparatus in Shop and Market

New Ideas In Making, Buying and Selling

A New Recording Thermometer

THE Brown Instrument Co., of Philadelphia, is placing on the market a new type of recording thermometer for temperatures up to 800 deg. F. (or 425 deg. C.) and operating on the principle of the expansion of gas with change in temperature. A bulb of copper containing nitrogen gas under pressure is connected to a recording instrument by a small copper tube protected by flexible steel tubing.

The recording instrument has a helical spring somewhat similar to that used in pressure gages, and the expansion of the gas in the bulb exerts a pressure which is conveyed by the capillary tube to the helix, which expands proportionately and which is directly connected to the recording arm.

THE BROWN INSTRUMENT CO. NEW RECORDING THERMOMETER

This instrument can be furnished with tubing 100 ft. in length, permitting its application in numerous processes where it is desirable to keep a constant temperature record.

The clock, which is of the Seth Thomas make, is mounted directly on the front plate on which the chart revolves, thus insuring alinement of the clock and chart plate.

The clips which hold the chart in position are mounted on the door, so that when the door is swung aside these clips are automatically swung away from the chart, permitting its easy replacement without interference. A device is furnished which raises the chart pen automatically when the door is opened, and again frees the pen when the door is closed.

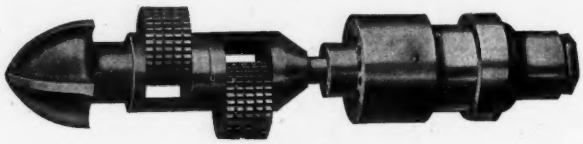
This instrument is made also in indicating form and with a number of different types of bulbs, either with threaded connection for insertion in mains and pipes, or with lead coating to withstand chemicals and acids.

Durable Boiler Tube Cleaner

FOR the boiler tube cleaner here described, its makers, the Rosedale Foundry & Machine Co., of Pittsburgh, Pa., claim simplicity of construction, durability and adaptability to all classes of tube cleaning.

Some of the essential features claimed for this cleaner are: Accessibility to the interior of the motor through a cap at either end; large motor shaft and long bearings; elimination of chattering and hammering of blades, and consequent wear.

The Holt motor is of the rotary type, and has but 8 parts—front and rear heads, front and rear bearings, cylinder sleeve, shaft and a set of shaft blades. The entire head of the motor is case-hardened, which lengthens the life of the motor head and causes it to retain its original diameter, thus preventing the motor from passing through the tube until all scale is removed.



MOTOR WITH DRILL HEAD ATTACHED

Only 2 motor blades are required, which are free to move back and forth as the shaft revolves. They are self-adjusting, and by bearing firmly against the inside walls of the cylinder, utilize fully the available air working pressure.

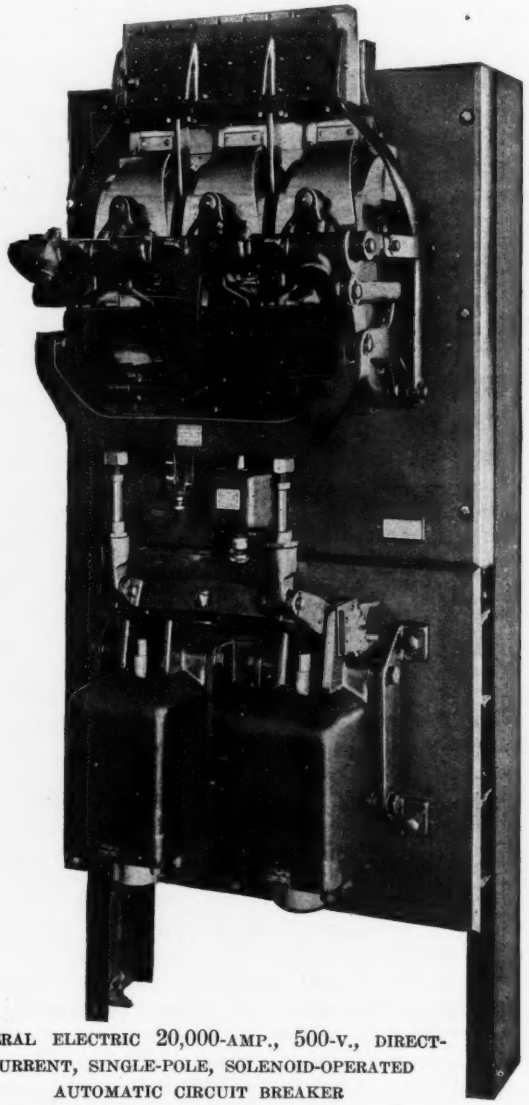
Bronze bearings support the shaft at each end, and the front end thrust is taken by a hardened steel washer. The cylinder is bored in such a manner that while the cylinder is set eccentric to the motor shaft, any distance measured across the bore is equidistant. This allows the shaft blades to have a bearing on each side of the cylinder wall.

Holt tube cleaners are made for standard sizes of tubes, 2 in. to 4 in. diameter, and sold under guarantee.

FOR ABSOLUTE SILENCING of the exhaust of a gas engine the volume of the muffler should be 15 to 20 times the total piston displacement. Customary practice is to use 6 to 8 times the displacement.—The Gas Engine.

A High-Capacity Circuit Breaker

THE 20,000-amp. direct current circuit breaker illustrated herewith is the most recent solenoid-operated type of circuit breaker developed by the General Electric Co. for controlling direct-current circuits of unusually high capacity. This circuit breaker is one of 4 of the same capacity built for the Aluminum Company of America for installation at Messena, N. Y. The closing and opening movements under normal conditions



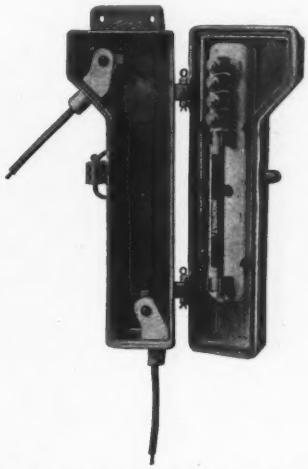
GENERAL ELECTRIC 20,000-AMP., 500-V., DIRECT-CURRENT, SINGLE-POLE, SOLENOID-OPERATED AUTOMATIC CIRCUIT BREAKER

are controlled by a single-pole double-throw control switch mounted remote from the breaker on the switchboard or in other convenient location. On overload or short circuit the breaker opens automatically by means of direct-acting trip. The breaker is mounted on a 2½-in. slate panel and the solenoid mechanism is supported by a steel base.

The use of solenoid-operated and other types of remote-controlled circuit breakers simplifies station wiring, reduces length of main cables, and economizes space at the point from which operations are controlled.

Single-Pole Lightning Arrester for Transformer Protection

FOR use on alternating-current circuits of any frequency, from 1000 to 2500 v., and of unlimited capacity, the Westinghouse Electric & Mfg. Co., has recently placed on the market the lightning arrester illustrated herewith. This arrester is for pole mounting and consists of 4 knurled, non-arcing, metal cylinders mounted on a porcelain base, with a series resistor which is held by fuse clips, the whole being mounted in a cast-



INTERIOR VIEW OF WESTINGHOUSE SINGLE-POLE LIGHTNING ARRESTER FOR TRANSFORMER PROTECTION

iron box. The arrester unit is mounted on the inside front cover of the box so that it is automatically disconnected from the circuit when the box is opened. This method of mounting is especially desirable in an arrester of this kind, which will ordinarily be used in considerable numbers on a circuit and receive routine inspection.

News Notes

RUSSELLVILLE, Brown County, Ohio, is taking bids for an electric lighting system in the village, particulars of which may be obtained from L. P. Hanselman, clerk.

DELAWARE, LACKAWANNA & WESTERN Railway has let a contract for a power house at Buffalo to F. D. Hyde, 90 West St., New York, for the sum of $18,000.

C. W. HAYS, formerly with Boyts, Porter & Co., Connellsville, Pa., is now associated with the Ross Mechanical Supply Co., of Pittsburgh, Pa., in charge of the pump department.

CLARAGE FAN CO., Kalamazoo, Mich., has established a branch office in Chicago at 123 W. Madison St., with L. O. Monroe in charge.

DUNKIRK, N. Y., is soon to have power from Niagara Falls, furnished by an extension of the lines of the Niagara & Erie Power Co. under a franchise from the city.

WALDRON POWER & ICE CO., of Waldron, Ark., has incorporated with $10,000 capital, and will build an electric lighting system and 5-ton ice plant.

ROBERT W. ROGERS has been engaged as chief engineer by the Superno Company, Inc., of New York City, in place of Edward A. Geoghegan, who is no longer with the company.

THE ERIE LIGHTING CO., of Erie, Pa., is planning a $20,000 addition to its power house at the foot of Peach St., contract for the building having been let to the Henry Shenk Co.

A POWER DAM is being constructed across the Holston River, 6 miles from Bristol, Tenn., and from the plant electric current will be transmitted to operate the street car system and supply power to Bristol.

MACON, GA., is considering the installation of a municipal lighting plant, four of the aldermen and City Engineer Humphreys having recently visited Jacksonville, Fla., to inspect the munipical plant there.

CHAS. S. KINNISON, formerly western advertising manager for the blast furnace and steel plant, has been appointed general sales manager for the Flota Mica Sales Co., with offices at 1201-2-3 Kresge Building, Detroit, Mich.

JAMES G. WRAY, chief engineer of the central group, Bell Telephone Companies, has resigned to become associated with the firm of Hagenah & Erickson, public utility engineers, First National Bank Building, Chicago.

H. W. DOW, who has been associated with the Engineering and sales departments of the Nordberg Mfg. Co., of Milwaukee, Wis., for 12 yr., has been appointed manager of sales for that company covering its lines of Corliss, poppet valve, uniflow and internal combustion engines, and air compressors.

THE TENTH CHICAGO CEMENT SHOW, which will be held early in February, 1917, has received so many applications for space that exhibitors are being requested to make application for the minimum amount in which the exhibit can be satisfactorily displayed. All the large cement companies have applied for space and most of the smaller ones.

In connection with this, the American Concrete Institute will meet at the Hotel La Salle, Feb. 8, 9 and 10.

YOUNGSTOWN, O., will probably grant a new franchise for 25 yr. to the Mahoning County Light Co. It provides a rate of 6 cents a kilowatt-hour with 5 per cent discount for cash, and a minimum charge of 50 cents a month. Present rates are 7 cents with $1 minimum monthly charge. The city is to have free $50,000 worth of current during the life of the franchise.

THE FIRM OF The Long Grate Bar Co., composed of Harry B. Spaulding and Ernest M. Hill, doing business in the city of Buffalo, N. Y., at 615 White Bldg., has been dissolved by mutual agreement, and the business, property and all assets formerly belonging to said firm have been transferred to Power Efficiency Corporation, a corporation organized under the laws of the State of New York, formed to carry on the business formerly carried on by the said firm.

THE H. W. JOHNS-MANVILLE CO. has just opened a new branch office at Great Falls, Mont., room 418, Ford Building, in charge of J. H. Roe. With the opening of the Great Falls office, the Johns-Manville Co. increases its number of branches to 55. This new branch is made necessary by rapidly increasing business in this territory. Great Falls, with its rapidly growing population of 38,000, is not only one of the greatest water power centers of the United States, but is known as one of the best wheat growing sections in the country, its wheat taking first prize at the Panama-Pacific Exposition.

ANDREW N. FOX has resigned as advertising manager of the Benjamin Electric Manufacturing Co., Chicago, to become president of the R. & F. Copper Mining Co., of Nevada, which will work an extensive property at Clarkdale, Nev., which has been owned by Mr. Fox and a partner for some years. Mr. Fox has been active in organization work among electrical men and advertising men in Chicago and was awarded the Big Brother Cup at Philadelphia last June in appreciation of work in organizing the greatest number of local advertising clubs. He is also a past-president of the Chicago Executive Club. Mr. Fox's new headquarters are located at 1911 Harris Trust Building, Chicago, Ill.

THE INDIANA WATER AND POWER CO., of Chicago, has bought the Bicknell Light and Power Co. plant at Bicknell, Ind., which will be dismantled and taken to Edwardsport. A larger plant will be constructed at Bicknell. The new company will provide light and power for several surrounding towns and is asking for franchises at Edwardsport, Westphalia, Sandborn, Marco, Lyons, Switz City and Bloomfield. A plant will be constructed at Bloomfield. A line will extend to Elnora, Odon and Newberry. The company also will assume the Lynn coal mine, the property of the local plant, which will be operated to provide coal for the 4 power stations which will be in operation in a short time.

IN MUNCIE, IND., the question is before the council of a franchise for electric light. Muncie Electric Light Co. is offering a new schedule of lower rates in an effort to secure renewal of franchise, but Jack Stockdale has offered a schedule of 6.5 cents a kilowatt-hour for lighting, with reductions down to 1 cent for use of over 20,000 kw.-hr. a month. For heating and cooking, a rate of 2.5 to 3.5 cents is offered. Boulevard lights are to be furnished at $30.14 each a year, as compared with the present rate, $34.18.

Mr. Stockdale offers $28,800 for the franchise, and gives the city of Muncie the right to buy the plant after a term of years at the physical valuation plus 20 per cent.

U. S. CIVIL SERVICE COMMISSION announces examinations, Nov. 8, as follows: Copyist draftsman, to fill vacancies in any bureau or branch of any bureau of the Navy Department, Washington, D. C., or any navy yard or other naval establishment of the United States, at entrance salaries of $2 to $3.44 a day; junior drainage engineer, to fill a vacancy in the Office of Public Roads and Rural Engineering, Department of Agriculture, at a salary ranging from $960 to $1440 a year; assistant

inspector of hull material, to fill vacancies as they may occur in this position, at $4.48 a day, at any navy yard or other naval establishment of the United States. Apply for Form 1312, stating the title of the examination for which the form is desired, to the U. S. Civil Service Commission, Washington, D. C.

U. S. CIVIL SERVICE COMMISSION announces an examination, Nov. 14, for general mechanic, to fill a vacancy at $720 a year in the Indian Service at Sax and Fox Sanitorium, Iowa, and vacancies as they may occur in positions requiring similar qualifications. Competitors will not be assembled for examination, but will be rated on physical ability, training and experience. Applicants must show that they have served apprenticeship or the equivalent both as carpenters and painters. Special credit will be given for experience in cement work. A rating of at least 70 per cent in the subject of physical ability, and also in that of training and experience, is a prerequisite for consideration. Applicants must have reached their twentieth but not their fiftieth birthday. Only eligibles without dependents will be considered for the specific position mentioned above. Apply for Forms 1800 and 2029, stating the title of the examination desired, to the U. S. Civil Service Commission.

U. S. CIVIL SERVICE COMMISSION announces examinations for assistant engineer and junior engineer, on Nov. 22 and 23, to fill vacancies as they may occur in the Reclamation Service, and in positions requiring similar qualifications, salaries of assistant engineers in the Reclamation Service ranging from $1500 upward; those of junior engineers, from $900 upward. Living expenses are not paid, except when traveling under official orders, when all necessary expenses are allowed. Applicants for Assistant Engineer must have had at least 4 yr. experience in engineering. Graduation from a technical course in a college of recognized standing will be accepted in lieu of 2 yr. of the required experience. The rating in training and experience will be based upon general experience in civil engineering, and upon technical description in detail of some important work upon which the competitor has been engaged. This description must be handed to the examiner on the day of the examination. Applicants must have reached their twenty-fifth but not their forty-fifth birthday. Competitors taking Junior Engineer Examination will be examined in the following subjects: Mathematics and applied mechanics, 25; theory and practice of construction on land and in water, 20; theory and practice of topographic and hydrographic surveying, 20; drawing and lettering (problem to show a knowledge of construction and use of contours), 15; training and experience, 20. In rating training and experience a minimum rating of 70 per cent will be given applicants who have just graduated or are about to graduate in civil engineering from any reputable technical school or college. Higher ratings will be given for special education or practical experience. Applicants must have reached their twentieth but not their forty-fifth birthday on the date of the examination. Persons who meet the requirements and desire either of these examinations should at once apply for Form 1312, stating the title of the examination desired, to the U. S. Civil Service Commission, Washington, D. C.

U. S. CIVIL SERVICE COMMISSION announces an examination, Nov. 14, for expert electrical and mechanical aid, to fill a vacancy at $12.48 a day, in the Bureau of Yards and Docks, Navy Department, Washington, D. C., and vacancies as they may occur in positions requiring similar qualifications. Duties cover the expert maintenance and supervision of the operation of all navy-yard power plants, embracing the economical production, distribution, and utilization of electric power for manufacturing, pumping dry docks, charging submarines, and for ships undergoing repairs; compressed air for manufacturing; steam for power and central heating, and production and distribution of hydraulic power; also investigations of power plant operating conditions, tests of plants and equipment, and efficiency engineering work in connection with improvement of operating conditions and instruction of plant operatives to obtain economical operating results. Graduation with a degree of mechanical or electrical engineer from a college or university of recognized standing, and at least 10 yr. subsequent experience in charge of the design, installation, and operation of central power plants and distribution systems for light, heat and power, with executive experience in handling successfully large numbers of power plant employes, are prerequisites for consideration. Applicants must not have reached fifty-fifth birthday. Apply for Form 1312.

Catalog Notes

"DIAMOND" TOOTH FORM for roller chain sprockets is the subject of a new catalog of Diamond chains, manufactured by Diamond Chain & Mfg. Co., of Indianapolis, Ind.

GENERAL ELECTRIC CO.'S Bulletin No. 44,419 deals with railway motor gears and pinions suitable for various classes of service and differing in chemical and physical characteristics.

THE 25TH ANNUAL EDITION of Hendricks' Commercial Register of the United States for Buyers and Sellers, which has just been issued, rounds out a quarter of a century of usefulness by this standard publication. The work is especially devoted to the interests of the architectural, contracting, electrical, engineering, hardware, iron, mechanical, mill, mining, quarrying, railroad, steel and kindred industries, containing above 350,000 names and addresses, with upward of 45,000 business classifications. Full lists are included of producers, manufacturers, dealers and consumers, listing all products, from the new material to the finished article, together with the concerns handling these products, from the producer to the consumer.

There are 1512 pages of text matter and the index of contents numbers 149 pages covering over 50,000 trade references. The list of trade names, brands, titles of identification, etc., is published for the first time and numbers 202 pages. This list furnishes ready reference for purchasing agents and prospective buyers to distinctive products manufactured by firms listed in the work.

AMERICA'S ELECTRICAL WEEK Handbook of Suggestions for central stations, manufacturers, jobbers, contractors and dealers, is being issued from the executive offices of The Society for Electrical Development, Inc., United Engineering Societies Bldg., New York.

THE KELVIN ENGINEERING Co., Inc., which became known several years ago for its revolutionizing originality in the complete electrification of Central Amistad, one of the largest cane sugar mills in Cuba, and since similarly equipped many other mills, has published a bulletin illustrating and describing some of the work done and the results accomplished. This shows by actual test data the economic comparison of modern electrification with the older steam drive. The bulletin also illustrates and describes sugar house apparatus, multiple effects, evaporators, vacuum pans. This bulletin is printed in both English and Spanish, and a copy of either will be sent upon addressing the home office, 32 Broadway, New York City.

CORRUGATED ASBESTOS ROOFING, manufactured by H. W. Johns-Manville Co., of New York, is discussed in a new pamphlet which also shows by halftone illustrations some buildings where the roofing withstands severe conditions.

J-M Transite asbestos shingles are the subject of another recent publication of the H. W. Johns-Manville Co.

THE WESTINGHOUSE Electric & Mfg. Co. recently issued leaflet 3919, covering Polyphase Induction Feeder-Voltage Regulators for medium and large capacities. The purpose of the feeder regulator, its construction and operation are thoroughly described.

Leaflet 3922, covering Equalizer Pedestals, issued by the same company, describes this piece of apparatus in some detail.

MECHANICAL RUBBER GOODS pamphlets have been received from Peerless Rubber Mfg. Co., 31 Warren St., New York, as follows: Catalog Section 110, on the subject of sheet packing gaskets; Section 111, on coil, spiral and ring packing; Section 112, combination packing power plant specialties; Section 113, under separate cover, is entitled, "Belting and Its Application."

BULLETINS were recently received from National Transit Pump and Machine Co., Oil City, Pa., as follows: No. 107, dealing with simplex and duplex horizontal direct-acting steam pumps, block valve type; Bulletin No. 201, on the subject of simplex and duplex horizontal power pumps.

GENERAL ELECTRIC CO.'S Bulletin No. 46,201 illustrates and describes single-phase watthour meters for house and switchboard service, explaining the advantages and construction of Types I-14 and IS-4.

Bulletin No. 46,253, from the same company, deals with polyphase watthour meters for house and switchboard service.

Bulletin No. 47,100 describes truck type safety first switchboards, of such construction that extensions can readily be made or the units moved to other locations to meet changed conditions.

PRACTICAL ENGINEER

Trade-mark, Reg. U. S. Pat. Off.

PUBLISHED ON THE FIRST AND FIFTEENTH OF EACH MONTH.

SEMI-MONTHLY

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Under classification "Position Wanted," advertisements not exceeding four lines will be inserted once for subscribers free of charge.

All copy should be received at Chicago office 18 days before date of publication.

Circulation of this issue, 22,500.

Technical Publishing Co.

537 S. Dearborn Street

Chicago

Position Wanted

POSITION WANTED—Young man, age 28, as engineer in New York or Brooklyn. Hold marine, stationary and refrigeration license. Day work, 8-10 hours, desires to go to school nights. Write for particulars. Box 452, Practical Engineer, 537 S. Dearborn St., Chicago, Ill. 10-1-2

POSITION WANTED—Young man wishes position as oiler or assistant engineer in a plant in New York City. Two years' practical experience. Write William Brand, 24 Locust Hill Ave., Yonkers, N. Y. 10-1-2

POSITION WANTED—As master mechanic, superintendent, chief engineer or erecting engineer. Have practical and technical experience in designing, erecting and operating central stations, power transmission and distributing systems, refrigerating and ice making plants and saw mills. For years connected with the largest machinery importing and engineering house in the Orient as estimator, selling and erecting engineer. Have traveled extensively, both in the Orient and Latin Americas. Know the Spanish and Italian languages. Have executive ability and can produce results. Will accept position to go anywhere for party offering proper inducements. Box 451, Practical Engineer, 537 S. Dearborn St., Chicago, Ill. 10-1-2

POSITION WANTED—Chief engineer, experienced on Steam Turbines and Condensers, Corliss and Automatic Engines, A.C. and D.C. Generators, Transformers and Meters. Have built and operated plants with my own capital. Have Ohio First Class Engineer's license Issue No. 6. Will be at liberty in 30 days or before if necessary. Will come on one month's trial to prove my ability. Age 30. Address J. A. Wise, Mowrystown, Ohio. 10-15-1

POSITION WANTED—I am a thoroughly competent power plant engineer, accustomed to handling on high efficiency basis all types of steam engines and turbines, A.C. and D.C. machines; strictly sober; 34 years old; married. Want charge of good plant in Chicago that will pay at least $25.00 per week. Address Box 455, Practical Engineer, 537 S. Dearborn St., Chicago. 10-15-1

STEAMFITTER—Accustomed to high pressure work wants permanent situation. American and strictly sober always; am not afraid of plenty of work. Can work from blue prints, as well as do all kinds of general repairs. Have some experience in millwright work and some knowledge of steam engineering. H. L. Simonds, Box 166, Sac City, Iowa.

POSITION WANTED—Young, sober and reliable married man, as engineer. Six years' experience with a.c. and d.c. compression ice plants, Corliss, high speed and slide valve engines. Ambitious. Desire change where advancement is possible. Open October 1st. R. Bruce, Caruthersville, Mo. 10-15-1

POSITION WANTED—As oiler, by young man, age 21, single. Willing to accept position in any city. Address Peter Stanys, 670 W. 18th St., Chicago, Ill. 11-1-1

Help Wanted

WANTED—Resident subscription agents in the following cities: Atlanta, Ga.; Cincinnati and Columbus, Ohio; Kansas City, Mo.; Los Angeles, Cal.; Louisville, Ky.; Newark, N. J.; New Orleans, La.; Portland, Ore.; St. Louis, Mo.; San Francisco, Cal.; Washington, D. C. This is an excellent chance for a hustler who is familiar with power plant conditions, to turn his spare time into dollars. To such a one we offer a Real Opportunity. Write Subscription Department, Practical Engineer, 537 S. Dearborn St., Chicago, Ill. tf.

Wanted

WE WANT A SALES ENGINEER or first-class Specialty Salesman to represent us in different localities for the sale of a mechanical device for boilers for which there is a universal demand. Interestd only in man now actually covering and soliciting power plant field, who has some general knowledge of boilers and who will tell in first letter what he is selling. A liberal commission insuring adequate compensation but only to desirable man. Be explicit regarding territory. Address Box 459, Practical Engineer, 537 S. Dearborn St., Chicago, Ill. 11-1-3

WANTED—Agents handling engine and boiler room specialties in every section for side line paying large commissions. Give experience, line carried and territory covered. Box 381, Practical Engineer, 537 S. Dearborn St., Chicago, Ill. tf.

WANTED—Well versed boiler and cumbustion salesman or established engineering agents to sell complete line of mechanical stokers, natural and forced draft; also steam jet ash handling system, on liberal commission lines. Box 453, Practical Engineer, 537 S. Dearborn St., Chicago, Ill. 10-1-4

WANTED—As partner, man with a little money and a lot of push, to take office end of steam specialty of superior merit and a necessity in every plant. A square deal for the man who becomes my partner and extra value for our customers. Investigate. Box 458, Practical Engineer, 537 S. Dearborn St., Chicago, Ill.

WANTED—Agents on commission to sell our shaking grates. We will install grates on trial or put it on test at our expense with any grate made. Address Armstrong Mfg. Co., Springfield, Ohio.

For Sale

FOR SALE—Engines: 16x36 Fishkill Corliss engine, entirely overhauled, $700; 10x24 Hewes Phillips Corliss engine, entirely overhauled, $375; 15x14 Ideal automatic engine, $400. Generators: 12-kw. Northern, 125-volt generator, direct connected vertical engine, $375; 40-kw. Sturtevant, 125-volt, direct connected generator and engine, $750; 100-kw. C. & C., 125-volt generator, direct connected Erie engine, $1000; 60-kw. Eddy, 125-volt generator, direct connected Ideal engine, $750. Power Machinery Exchange, Inc., 1 Montgomery St., Jersey City, N. J. 11-1-1

GAS ENGINE FOR SALE—One 15-hp. 2-cylinder Westinghouse gas engine for sale in good condition. No reasonable offer refused. Correspond with E. B. Latham & Co., 4 Murray St., New York City. 10-15-6

FOR SALE—Light Plant. 1000 people; north Missouri; paying well. $1500 cash required. Box 26, Gorin, Mo. 11-1-1

Patents and Patent Attorneys

PATENTS THAT PROTECT AND PAY—Advice and books free. High references. Best results. Promptness assured. Send sketch or model for search. WATSON E. COLEMAN, Patent Lawyer, 624 F. St., N. W., Washington D. C. tf.

PATENTS—C. L. Parker, Attorney-at-Law and Solicitor of Patents. Patents secured promptly and with special regard to the legal protection of the invention. Handbook for inventors sent upon request. Washington, D. C. tf.

PATENTS—H. W. T. Jenner, Patent Attorney and Mechanical Expert, 606 F. St., Washington, D. C. Established 1883. I make a free examination and report if a patent can be had, and the exact costs. Send for full information. tf.

A. P. CONNOR. Consulting Electrical and Mechanical Engineer, Attorney-at-Law and Solicitor of Patents and Trade-Marks. Results guaranteed. 121 Carroll St., S. E., Washington, D. C. tf.-x.

PATENTS—Send sketch for free search and reports. Books and patents and book of reference letters sent free. John S. Duffie & Co., 612 F. St., Washington, D. C. tf.

PATENTABLE IDEAS WANTED—Send for three free books. R. B. Owen, 28 Owen Bldg., Washington, D. C. tf.

Technical Books

FREE ENGINEER BOOKS and power plant tools and specialties, for securing new subscribers to Practical Engineer. A dandy chance for the engineer with a little spare time, to get some fine premiums. Send for free descriptive circular and terms. Subscription Department, Practical Engineer, 537 S. Dearborn St., Chicago, Ill.

A STEP IN STEAM. Over 250 questions and answers on boilers, their care, management, etc., mailed to any address on receipt of one dollar. Sample pages ten cents. Richmond Engineering Bureau, Box 353, Haverhill, Mass. 11-1-1

Miscellaneous

ENGINEERS, DO YOU WANT to utilize your exhaust steam for heating or drying purposes without back pressure on your engine? If so, address Monash Engineering Co., 1413 W. Jackson Blvd., Chicago, Ill. tf.

Sparks From The Advertising Pages

See America First

And this is by no means unseasonable advice.

See America First!

See her first in the things that make for a better nation and a fitter place of habitation.

We do not know—we cannot even surmise what the next few months will bring forth in national and world events, but we do know that seeing America First, seeing her above all nations and monarchs—seeing her efficient—and just—and peaceful—and progressive, is seeing her above and beyond any one-sided domination or any political creed ever written.

The spirit of patriotism—the natural emotion in the breast of the true American will guide us in the pursuit of material progress.

Peace—and then what, is a crucial question. Peace—and the markets of the world are open to us—old markets restored—new ones created with the possibility of their further development intensified, and Publicity will connect the continent with bonds of commercial and industrial progress—Publicity will forever stop the red lash of war and stifle the smoldering flames of hatred.

We live in an age of industry. It inspires the spirit of progress, but not until each integral part of business is in complete correlation, will its greatest progress be manifest. When producer and consumer—when manufacturer and laborer evince the spirit of reciprocity, then will our material assets be increased. Surely it is but just that an American manufacturer who makes known his wares receive the patronage of the consumer. When the consumer realizes this he will understand the rightful meaning of patriotism, for this is patriotism in its sincerest sense. The greatest measure of it does not manifest itself on the fields of battle, but in the home and the busy marts of the world.

What need we fear although, after international readjustment foreign goods are dumped on our shores, if publicity methods are established to build up and maintain a national demand for the products of home-industry, assuming that the quality of the products, perforce, is maintained.

We are blessed with the horn of plenty—the symbol of peace and prosperity—we are in truth the creditor nation of the world. We are vested with power incomparable. If we abuse this power in part or in whole it will be taken from us, but if we use it to acquire the things that are necessary to lay the foundation for the right kind of living, it will be increased. So it is business intensified—the warp and woof of life, itself—business invigorated and accelerated by the beneficent power—Publicity—that is most helpful in the solution of the larger problems of life.

Elaborate these in rightful proportions, and our nation's equilibrium will be maintained—Then will she balance the arts with the industries—then and then only can we truly say, See! America is First.